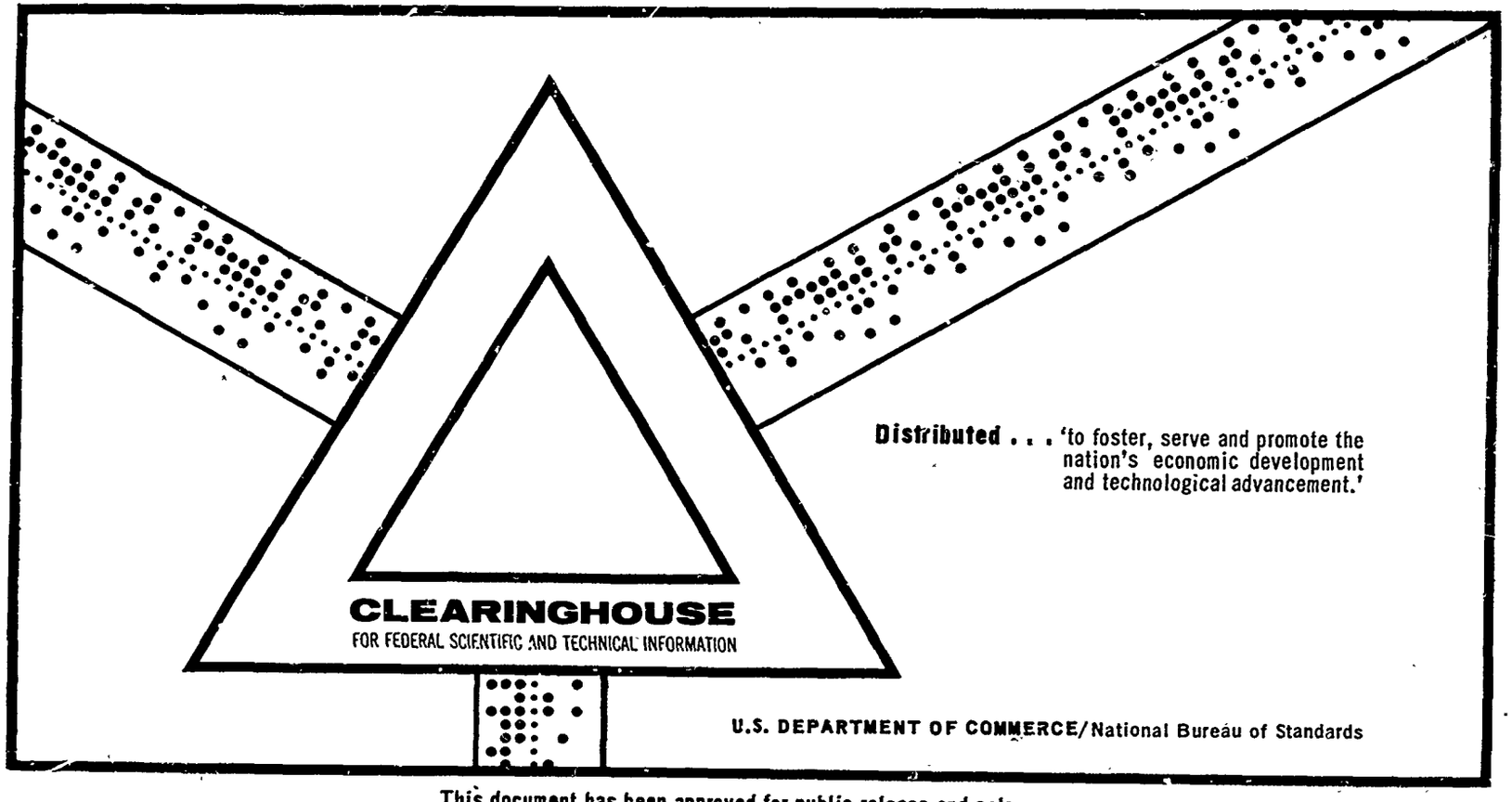
MANPOWER RESOURCES INTEGRATION GUIDE FOR ARMY MATERIEL DEVELOPMENT

Human Engineering Laboratories
Aberdeen Proving Ground, Maryland

30 January 1969



U.S. ARMY

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HUMAN ENGINEERING LABORATORIES

ABERDEEN PROVING GROUND, MARYLAND

CONTENTS

INTRODUCTION

1. Purpose

The purpose of this guide* is to explain and promulgate the procedures for integrating the AMC Human Factors Engineering Program (~~AMCR 70-1~~) with the Life Cycle Management Model for Army Systems, (~~DA Pamphlet 11-25~~).

2. Background

As a result of efforts by the Brown Board and other groups to define and describe an optimum sequence for materiel development in the Army, a "management model" has been adopted. While not every new materiel end item may be the direct result of action in each block of the model, provision is nevertheless made in the model to insure that all of the R&D resources of the Army are made available as required and in a logical sequence.

AR 602-1, dated 4 March 1968, provides for a DA-wide human factors engineering (HFE) program. This program, to be effective in meeting its objectives (para 3 below), needs to interface with other organized R&D efforts at certain specific times and places. This guide delineates in the HFE Program Model those HFE activities and outputs which insure that the AMC HFE Program is responsive to and complementary with the Life Cycle Management Model (LCMM) of the Department of the Army.

The term "HFE" in the sense in which it is used in AR 602-1 and in this guide encompasses all of the "human" factors with which materiel developers must be concerned. Although separate Army agencies exist to handle the selection, classification, and training of the personnel who will ultimately operate and maintain new equipment, it is important that the aspects of manpower resources administered by those agencies be considered during materiel development. Consequently, "HFE" as defined by AR 602-1 includes:

a. That part of system analysis that determines man's role in a man-materiel system.

b. Selection, definition, and development of man-materiel interface characteristics, workspace layout, and work environment conducive to effective and efficient performance under expected use conditions.

*This guide supersedes HEL Guide 1-68, Mar 68; HEL Guide 1-69, 2 Jan 69; and HEL Standard S-4-65, Jan 65

c. Determining the needs for, and then developing and evaluating job procedures, performance aids, and training devices, aids, equipment, and publications.

d. Providing basic man-machine task sequence data used to describe, develop, and assess the feasibility of the human performance required in a man-materiel system.

e. Developing equipment which permits effective man-equipment interaction under special limitations in the training time, aptitudes, skills or physical standards.

f. Determining number and kinds of military and civilian personnel needed in a man-materiel system for cost effectiveness analyses when evaluating various design concepts and for subsequent personnel planning, and providing the data needed for modifying current MOS or establishing new MOS required by new equipment, doctrine, or organization.

g. Assessing the training burden which competing materiel design concepts may impose on the Army.

h. Developing the information needed for new or revised training plans, courses, or programs of instruction as required by new or modified materiel, doctrine, or organization.

i. Assessing HFE as described above by evaluating the man-equipment combination.

3. Objectives of the AMC HFE Program

a. To achieve the most effective, efficient, and reliable man-equipment combination under use conditions by integrating human performanc information into system design.

b. To insure that materiel is developed so that the human tasks involved in operating, maintaining, and supplying the Army's equipment and weapons do not exceed the capabilities of the manpower resources available to the Army.

c. To insure that training on specific equipment is feasible, effective, sufficient, necessary, and integrated into the Army training program.

d. To improve control of total life cycle costs of man-materiel systems by assuring consideration, early in the materiel life cycle, of the cost of manpower resources and training for alternative systems.

e. To reduce skill levels, training, and manpower required by equipment.

f. To develop human performance data, integrate it with system performance data, determine new performance requirements, evaluate personnel feasibility, and provide for the timely development of the necessary trained manpower resources.

g. To insure that systems safety engineering is considered.

h. To provide data for the development of technical manuals, training manuals, field manuals, and other technical publications and insure that the use of these publications does not require aptitudes, education, or training beyond that required to perform the tasks they describe.

i. To apply technology to design and development of training devices.

4. Use of this Guide

a. This guide is intended for use and reference by all Army agencies which are concerned with HFE work in support of materiel requirements or development. Although the procedures set forth herein are specifically applicable to the Army Materiel Command and its subordinate commands and related agencies, the guide is written in such a manner that it may be used by any of the developing agencies specificed in AR 705-5. Consequently, the term "developing agency" as used in the explanations of the HFE Program Model refers to the major Army agency charged by regulation with the responsibility for development. In actual practice within AMC, it is usually the policy to delegate authority for the initial management of a particular project to the appropriate commodity command or laboratory. When such authority has been delegated by Hq, AMC, the subordinate command or agency performs those functions ascribed to the "developing agency."

b. This guide has attempted to take cognizance of all existing Army Regulations which apply to the subjects discussed herein. In particular, project managers should find that, although this guide allows them flexibility in handling particular project problems, it also simplifies the handling of those problems by providing an adequate set of procedures which are designed to fulfill the HFE requirements of para 7c, AR 70-71. Users of this guide are encouraged to submit recommended changes or comments to improve the guide. Comments should be keyed to the specific page, paragraph and line of text in which the change is recommended. Reasons should be provided for each comment to facilitate understanding and evaluation. Comments should be forwarded on DA Form 2028 to the Technical Director, USAHEL, Aberdeen Proving Ground, Maryland 21005.

c. The format of this guide is two-fold: Diagrams of the HFE Program Model interfacing with the Life Cycle Management Model, and textual explanations of each block of the HFE Program Model. The diagrams and texts are designed to be used together, and neither will be entirely intelligible without the other. The HFE Program Model indicates both the category and the HFE actions which are required in the flow of the LCMM. In an endeavor to make the explanations of the blocks of the HFE Program Model as readable as possible (and the guide as a whole easier to use) care has been taken to omit unnecessary elaborations of processes within the LCMM itself. Instead, emphasis is placed on clear, concise and complete descriptions of the HFE actions required. As an additional aid to the reader, the explanation of each HFE block has its main points summarized above the text.

d. To be useful as a general planning guide the system described herein must be able to respond equally well to the development of all types of Army materiel. Whether the materiel end item is a new can opener for C rations or a complex machine requiring the simultaneous operation of 20 highly skilled technicians, the procedures must insure that correct amounts of HFE effort are applied at the appropriate place in the development sequence. Where possible, responsibility has been specifically assigned for the action required in each of the HFE blocks on the accompanying diagrams. Inasmuch as the degree of HFE involvement and participation will vary with the nature of the materiel item under development, responsibility for certain specific HFE tasks must be assigned among the Army agencies concerned at appropriate places in the development sequence. Implicit at these places is the option not to assign responsibility and not to perform work if none is required in that particular project. For example, HFE Block 3 requires the planning of HFE efforts during exploratory development.

It is intended that, of the possible efforts described in HFE Block 4, only those specifically applicable to the particular project under consideration will be scheduled in HFE Block 3. Moreover, it is not until after the appropriate efforts have been selected that the HFE agencies upon which work requirements will be levied should be determined.

The system should thus be able to draw most efficiently from the resources of each of the various Army agencies involved in HFE by coordinating their efforts from the outset. It is always intended, however, that an AMC HFE agency (either the USA Human Engineering Laboratories or an AMC subordinate command HFE unit) serve as the system HFE coordinator, and provide the avenue through which other non-AMC human factors organizations make their respective contributions.

SECTION I

Concept Formulation Phase

BLOCK 1 - RESEARCH

HFE Responsibility

Authorized Army agencies

Output

Technical reports

Summary

Perform systematic investigations to establish facts or principles, or to generate quantitative human performance data.

Prepare and publish reports

Army agencies authorized RDTE funds perform research in accordance with the Army Research Plan. The work is often referred to as "basic research" and is directed toward establishing a base of knowledge from which long range concepts and objectives may later be achieved. Although HFE basic research covers a wide range of topics and involves many ordinarily autonomous disciplines (such as medicine, sociology, mathematics, education, physics, psychology and engineering), the common focus of this research is the expansion of knowledge regarding basic capabilities and limitations of man under various environmental, training, and operational conditions.

Ordinarily the results of basic research do not directly affect current materiel development. However, reports of scientific breakthroughs or state-of-the-art advances are assessed by planning agencies for impact on current and future military requirements. A particular scientific advance may warrant the initiation of a QMDO.

Even though this block appears at the beginning of the life cycle, it should be understood that research is a continuing activity and that outputs from it are continuously used in Army planning and materiel development.

BLOCK 2 - PREPARE HFE INPUT TO PQMDO

HFE Responsibility

Designated by developing agency

Output

HFE Requirements List

Summary

Review objectives

Delineate HFE areas of involvement

Outline HFE research requirements

Determine participation by Army HFE agencies

This block may be considered the beginning of the materiel development life cycle from the HFE standpoint. It is at this point that a formal materiel development objective is generated by CDC. The designated HFE agency initially reviews the PQMDO for the developing agency to determine whether or not HFE input is appropriate.

If the PQMDO appears to warrant HFE considerations, the HFE agency:

a. Reviews the operational problems or needs which generated the materiel development objective to better understand the scope of the objectives.

b. Indicates the significant HFE implications and the problem areas which will require study.

c. Outlines the general areas of HFE effort required if the PQMDO is approved and estimates the gross manpower, costs, and schedule of work. These gross estimates identify, for the QMDO approval authority, the scope of effort required if the PQMDO is approved.

d. Determines the desirable participation by Army HFE agencies.

e. Determines whether there are additional PQMDO qualifying statements (delineating the nature of the objective, intent of the user or other pertinent information) which must be stated before the HFE portion of a QMDO plan can be prepared.

Tentative supersession, para 1, page 8 (17 Apr 69)

This block may be considered the beginning of the materiel development life cycle from the HFE standpoint. It is at this point that a formal materiel development objective is issued by CDC. The developing agency then designates an HFE element to be responsible--through the developing agency--for the integration of manpower resources into all subsequent development efforts during Concept Formulation. (When AMC is the developer, the subordinate command or agency given "prime responsibility" in accordance with Vol 4, AMCP 705-1 designates an AMC HFE element to perform the system HFE integration).

Tentative supersession, para d, page 8 (17 Apr 69)

d. Lists the Army commands, organizations and agencies who have responsibilities and/or resources within the scope of HFE and whose support for the development effort would be solicited if the PQMDO is approved.

Tentative supersession, para 2, page 9 (17 Apr 69)

The HFE element assigned (in HFE Block 2) responsibility for the manpower resources integration work establishes the nucleus of an HFE Concept Team and solicits the participation on that team of the Army commands, organizations and agencies whose specialized knowledge or resources within HFE appear to be able to contribute to the achievement of the objectives of para 3, AR 602-1. This HFE Concept Team will be responsible for:

BLOCK 3 - PREPARE HFE INPUTS TO QMDO PLAN

HFE Responsibility

Designated by developing agency

Output

HFE portion of QMDO Plan

Summary

Establish HFE Concept Team

Review system concepts

Consider state-of-the-art

Establish HFE agency responsibilities

Prepare HFE portion of QMDO Plan (if appropriate)

Following approval of the QMDO by DA, the technical and engineering resources of the developing agency study the QMDO, enumerate all the various technical approaches which might be applied to satisfy the materiel development objective elucidated in the QMDO, and generate as many system concepts employing these technical approaches as possible. These technical approaches and their attendant system concepts are then stated in the QMDO Plan being prepared.

While this work is going on, the developing agency designates an HFE agency which will be responsible for coordinating the manpower resources integration work done in response to the QMDO. This will usually be the same agency designated in HFE Block 2. This designated HFE agency establishes an HFE Concept Team, which will consist of representatives of Army HFE agencies concerned with the QMDO. This HFE Concept Team will be responsible for:

a. Studying that part of the QMDO Plan prepared thus far and reviewing the technical approaches and their attendant system concepts provided by the technical and engineering resources of the developing agency.

b. Considering the state-of-the-art as appropriate to the subject.

c. Deciding whether or not research is required to determine the HFE feasibility of any of the concepts.

(1) If the team determines that the HFE state-of-the-art is sufficiently advanced (or that the likely materiel end item is sufficiently simple) so that a determination can be made at this time that all system concepts are feasible from the HFE viewpoint, no HFE work is planned for Exploratory Development. (Go directly to HFE Block 6.)

(2) If it appears that the HFE feasibility of any of the system concepts has not been established or is in doubt, the team determines what research will be required to establish whether or not the concept(s) is feasible. The team prepares specific research requirements which are levied on the appropriate HFE agencies and then prepares a comprehensive plan for that research which will:

(a) Outline a systematic and preferably quantitative method by which the feasibility of the alternative QMDO system concepts can be investigated and determined.

(b) Assure that all manpower characteristics (such as personnel skills, training requirements, behavioral reactions, human performance, anthropometric data, biomedical factors, safety engineering, etc.) are considered.

(c) Describe the general nature of the required research.

(d) Provide specific guidance for the conduct of each research task levied by the HFE Concept Team.

(e) Provide manpower, time and cost estimates.

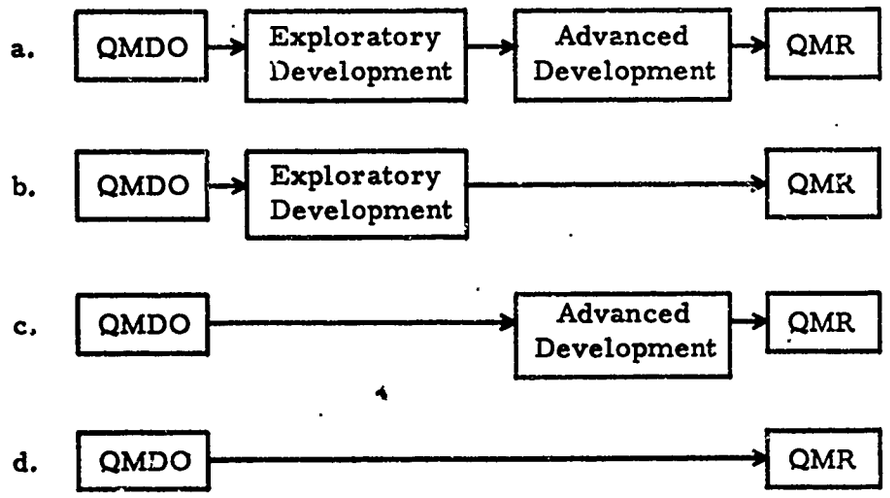
(f) State interactions with other aspects of the project which may be required.

(g) Describe the data collection methods to be used and the methods and times for reporting results.

In some cases the developing agency may request that the HFE portion of the QMDO plan be submitted on DD Form 1498 (see AR 705-27). Use of this form does not, however, relieve the HFE Concept Team of the responsibility for planning all of the elements in subparagraphs (a) through)g) above.

Care should be taken during the planning of the HFE effort for Exploratory Development to insure that the efforts of the participating HFE agencies are complementary and not duplicative. Attainment of this objective will largely be influenced by the degree to which the performance of the research tasks are controlled and coordinated by the HFE Concept Team and the degree to which research results from one HFE agency are promptly disseminated to the other agencies concerned.

Because the efforts described under HFE Blocks 4 (Exploratory Development) and 8 (Advanced Development) are not necessarily required for each project, there are four routes by which a QMDO may evolve into a QMR. These routes are diagrammed below:



While it is not the intent of this block to select one route (i.e., the decision whether or not to schedule Advanced Development should not be made until HFE Block 7), the agency performing the work described in this block should be cognizant of these four routes and of the distinctions between exploratory and advanced development (as outlined in paragraph 1-6, AR 705-5).

BLOCK 3a - HUMAN PERFORMANCE REQUIREMENTS

HFE Responsibility

Determined in HFE Block 3

Output

Human Performance Requirements Section of HFE portion of QMDO Plan

Summary

Review QMDO and supporting material

Study proposed system concepts

Determine extent of HFE effort required

Plan manpower, cost and schedule

Designated members of the HFE Concept Team review the QMDO and its supporting material to insure understanding of the concepts involved. The system concepts proposed by the developing agency are then studied to determine on a gross level the likely human performance requirements for operation, maintenance, and support of the system. Consideration will be given to possible operational modes of the system and to the likely environment for human operators in each mode.

If, after this initial study, it is not overwhelmingly apparent that the proposed system concepts do not overtax human capacity or create unfavorable environments for human operators, those HFE efforts described in HFE Blocks 4a, b, and h will be scheduled.

Planning for the accomplishment of the work in those blocks will be in accordance with the outline in HFE Block 3.

BLOCK 3b - PERSONNEL REQUIREMENTS

HFE Responsibility

Determined in HFE Block 3

Output

Personnel Requirements section of HFE portion of QMDO Plan

Summary

Review QMDO and supporting material

Study proposed system concepts

Determine extent of HFE effort required

Plan manpower, cost and schedule

Designated members of the HFE Concept Team review the QMDO and its supporting material to insure understanding of the concepts involved. The system concepts proposed by the developing agency are then studied to determine on a gross level the number and types of personnel which might be required for operation, maintenance, and support of the system.

If it is not overwhelmingly apparent that the numbers and types of personnel likely to be required by each system concept are readily available in sufficient quantity in the Army manpower pool, those HFE efforts described in HFE Blocks 4c and 4e will be scheduled.

Planning for the accomplishment of the work in those blocks will be in accordance with the outline in HFE Block 3.

BLOCK 3c - TRAINING REQUIREMENTS

HFE Responsibility

Determined in HFE Block 3

Output

Training Requirements Section of HFE portion of QMDO Plan

Summary

Review QMDO and supporting material

Study proposed system concepts

Determine extent of HFE effort required

Plan manpower, cost and schedule

HFE, as a comprehensive effort to integrate all manpower characteristics (including training) into Army systems, must concern itself with training requirements and considerations early in the development cycle. Among the reasons for this early attention to training are:

a. Long lead-time planning is necessary in order to provide operationally ready individuals, crews, and units on time and in the numbers required.

b. Training problems and information requirements must be established early to enable the planning and conduct of research necessary to resolve the problems.

c. There is a need to ake an early analysis of existing training courses, equipment, and facilities to determine their suitability or adaptability for the proposed systems.

The work described in this block requires that members of the HFE Concept Team review the QMDO and its supporting material to insure understanding of the concepts involved. The system concepts

proposed by the developing agency are then studied to determine on a gross level the training requirements for operation, maintenance, and support personnel.

If it is not overwhelmingly apparent that both the training requirements (including training devices, equipment, facilities and personnel) and life cycle training costs for each system concept are identifiable and reasonable, then the HFE efforts described in HFE Blocks 4d, f, and g will be scheduled.

Planning for the accomplishment of the work in those blocks will be in accordance with the outline in HFE Block 3.

BLOCK 4 - HFE EXPLORATORY DEVELOPMENT

HFE Responsibility

HFE Concept Team

Output

Technical reports

Summary

Perform HFE research and tasks in support of QMDO

When the QMDO has been reviewed by DA and Exploratory Development has been authorized, that HFE research work described in the QMDO Plan (HFE Block 3) is begun. Each Army HFE agency which is participating in the work will appoint at least one representative to the HFE Concept Team. This representative will keep the team informed of the progress of his agency's work and research findings. Coordination of HFE efforts among the participating agencies will be made at this team level.

The focus of work during Exploratory Development is determining the feasibility from the HFE standpoint of the system concepts under consideration. If a particular system concept is feasible from every other respect although it requires a human operator to perform beyond the limits of human capacity or in an intolerable environment, then the entire system concept is not feasible. Clearly, it is the responsibility of HFE agencies to make such a determination and to inform the developing agency promptly. Often, however, especially in considering innovative systems, intuition and common sense alone are insufficient to determine HFE feasibility, and the required data are not known to exist. Exploratory Development is the appropriate time to gather this data.

Some of the information generated during this HFE effort, such as QQPRI data, training facilities required, and associated costs, provides a base from which a more general decision of feasibility can be made. Although this general decision lies outside the scope of HFE responsibility, all pertinent information should be made available to the appropriate decision makers.

BLOCK 4a - PERFORM INITIAL FUNCTION AND TASK ALLOCATION STUDIES

HFE Responsibility

Determined in HFE Block 3

Output

Report of feasibility of human performance in each system concept

Summary

Review QMDO and supporting material

Construct flow charts for each system concept

Explore possible gross function and task allocations

Determine feasibility of each

That agency designated in HFE Block 3 begins these studies in accordance with the QMDO plan upon instructions from the HFE Concept Team. The designated agency first reviews the QMDO and its supporting material to insure understanding of the system concepts being studied. Next are listed--usually by flow charts--the sequence(s) of events, processes or tasks for each system concept from activation input to final output. The possible allocations between man and machine of each gross function and task are then compared to an HFE criterion of feasibility. Additional criteria of feasibility should be adopted when appropriate, but the general criterion to be used is: "Can human operators reasonably be expected to perform this function or task reliably?"

When the answer to this question is not immediately obvious, studies employing troops, simulated equipment and special environments may be required. For example, a given system concept might require that incoming hostile missiles be classified into live warheads and decoys. One criterion question should be whether human radar operators

could reliably analyze and classify the radar data and initiate the required response within the operational time limits. After a performance test with trained radar operators, the allocation studies might show that:

a. existing automatic techniques perform the classification correctly more reliably than human operators,

b. only highly trained operators could provide the required performance,

c. a large number of operators would be required, or

d. human operators using existing hardware could perform as required, and the expense of the alternative automatic technique could be avoided.

The final report of these initial function and task allocation studies will indicate those gross functions and tasks required for operation, maintenance, and support of the system, whose allocation to human operators is considered feasible. These human performance tasks are then grouped by probable performer (e.g., "driver's tasks").

BLOCK 4b - PERFORM INITIAL ENVIRONMENTAL STUDIES

HFE Responsibility

Determined in HFE Block 3

Output

Report of effects of operational environment on human performance for each system concept

Summary

Review QMDO and supporting material

Study flow charts from allocation studies

Determine environmental influences on human performance

The agency designated in HFE Block 3 begins these studies in accordance with the QMDO Plan upon receipt of initial reports from the initial function and task allocation studies (HFE Block 4a). The agency reviews the QMDO and its supporting material to insure understanding of the system concepts under consideration and then studies data from the allocation studies to determine the gross range of functions and tasks which might be assigned to human operators. Unusual characteristics of system materiel (e.g., radioactive) or intended use (e.g., movement during blizzard) are determined from the QMDO.

Studies are then conducted--as appropriate--which:

a. determine the limits of human performance in various system operation modes, and

b. determine and describe the hazards to personnel, if any, which might occur from contact with or proximity to the system. If hazards are found to exist, their effect (direct and cumulative) on human performance limits will also be studied.

The final report of the environmental studies will assess the feasibility of each system concept as one of the following:

a. Feasible as stated--the limits of human capacity are not strained by any operational mode and there are no hazards to personnel incurred from proximity to the system.

b. Not feasible--the limits of human capacity are exceeded and/or serious hazards exist from which the human operator(s) cannot be protected.

c. Feasible with restrictions--the system as envisioned is feasible provided certain restrictions are accepted. These restrictions may include specifications of minimum number of operators, prescribed work lengths, special personnel requirements or protection devices.

Normally the environmental studies will be preceded by the function and task allocation studies (HFE Block 4a). There may be occasions, however, when, for example, the feasibility of a function allocation will be influenced by the result of an environmental study. The HFE Concept Team will therefore insure the close coordination of these two sets of studies.

BLOCK 4c - DEVELOP ESTIMATE OF PERSONNEL REQUIREMENTS

HFE Responsibility

Determined in HFE Block 3

Output

Report of estimate of personnel requirements for each system concept

Summary

Review allocation and hazard studies

Develop estimates of personnel requirements

Compare requirements with anticipated resources

The agency designated in HFE Block 3 begins this work in accordance with the QMDO Plan by reviewing the function and task allocation study report (HFE Block 4a). The task groups established in HFE Block 4a are then analyzed to determine gross aptitude and skill levels required. The designated agency then reviews the environmental study report (HFE Block 4b) to determine the existence of any peculiar personnel requirements (e.g., perfect color vision, depth perception, or kinesthesia).

Estimates of personnel requirements are then developed which specify for each system concept the number and type (by grade and MOS) of personnel and their skills and aptitudes (to include limiting factors). If the personnel requirements of any system concept cannot be met from the anticipated Army manpower resources, the steps necessary to meet the requirements will be indicated and the cost of those steps estimated.

Although the data produced in this block are primarily intended for use in determining system feasibility, they are also the foundation for subsequent personnel work in the event the system concept is carried into further development. Consequently, the HFE agency performing this work should be aware of the information requirements which may arise in the future (QQPRI and NEPRS, AR 611-1; and NETP, AR 350-12) and perform the work of this block in such a manner that later duplication or overlapping effort can be avoided.

BLOCK 4d - DEVELOP ESTIMATES OF REQUIRED TRAINING

HFE Responsibility

Determined in HFE Block 3

Output

Report of estimate of training required for each system concept

Summary

Review QMDO system concepts and supporting material

Study task allocation, environmental and personnel requirements reports

Develop estimate of training required for each system concept

Compare estimates with anticipated training resources

The agency designated in HFE Block 3 begins this work in accordance with the QMDO Plan by reviewing the system concepts provided by the developing agency. Reports of the function and task allocation and environmental studies (HFE Blocks 4a and b) and the estimate of personnel requirements (HFE Block 4c) are studied to determine (1) the levels of human performance required and (2) the quantity and skill levels of personnel required.

Although the work in this block is the foundation for all subsequent training efforts, its primary focus at this time is on assessing the feasibility of the training required for each system concept and not on planning a detailed training program.

The technical feasibility of training--that is, that a performance task within the range of human capability can be taught to individuals selected on the basis of a task-related skill--is assumed at this point. This is because any performance task not within the range of human capability would have been discovered and eliminated from further consideration during the work in HFE Blocks 4a and b, and HFE Block 4c would have indicated the non-availability of personnel with the requisite task-related skill(s).

However, since total feasibility depends on both technical feasibility and cost-effective feasibility, considerations such as how much time and money and what facilities are required to train operation, maintenance, and support personnel must be established during exploratory development. Consequently, the report of required training prepared here should include estimates of:

a. Required courses for individual training in operation and maintenance.

b. The numbers, length, and frequency of such courses.

c. The number of students, instructors, and support personnel required.

d. Required unit training.

e. Overall costs (manpower and funds) for a through d above.

Enough information must be accumulated to determine (1) whether the training requirements of a proposed system concept are feasible, and (2) what impact these requirements will have upon the Army. The final report of this block will classify the training requirements of each system concept as either:

a. Feasible within present programs and training capabilities, or

b. Feasible but requiring additional capabilities and programs as specified.

Throughout the work in this block note should be made of any requirements which are uncovered for training research, either to support a determination of cost-effective feasibility or for longer-range refinement of training methods. The clear stating of such requirements is important not only in estimating total system costs, but also in providing useful inputs to the identification of training research requirements (HFE Block 4g).

BLOCK 4e - IDENTIFY PERSONNEL SELECTION RESEARCH REQUIREMENTS

HFE Responsibility

Determined in HFE Block 3

Output

Report of research required to develop personnel selection criteria for each system concept.

Summary

Review estimates of personnel requirements

Determine adequacy of selection criteria

Identify research requirements

Conduct research as required

The agency designated in HFE Block 3 begins this work in accordance with the QMDO Plan upon receipt of the estimates of personnel requirements (HFE Block 4c). The requirements estimate for each concept is studied to determine whether or not there are adequate criteria to be employed in the selection of personnel to man the system. Where adequate criteria exist, selection procedures will be indicated. Where adequate criteria do not exist, the research required to establish them will be described (to include a general description of the work, manpower, time and cost estimates, and a statement of interactions with other aspects of the project which may be required).

Although the research requirements identified in this block are normally conducted during or after Advanced Development, it is within the purview of this block to conduct research to resolve personnel selection problems which have a direct bearing on the determination of the feasibility of a system concept.

BLOCK 4f - DETERMINE TRAINING EQUIPMENT AND FACILITIES REQUIREMENTS

HFE Responsibility

Determined in HFE Block 3

Output

Report of probable requirements for training equipment and facilities for each system concept.

Summary

Review estimates of required training for each system concept

Determine training equipment and facilities required by each system concept

Compare requirements with present and anticipated training resources

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The agency designated in HFE Block 3 begins this work in accordance with the QMDO Plan upon receipt of the estimates of required training (HFE Block 4d). These estimates are studied to determine what specific tasks, skills and knowledge must be learned or acquired to make the required human performance within the system possible, and what are the types and extent of training proposed. Based on this information, probable requirements for training devices, equipment, publications, and facilities are determined for each system concept.

These probable requirements are then compared to present and anticipated training resources, and estimates are made of additional training equipment and facilities which would be required by each system concept.

These estimates provide information which should influence the determination of both the cost-effective feasibility, and impact on the Army, of each system concept.

The final report of this block should contain, for each system concept requiring additional training equipment or facilities--

1. A brief functional description of the equipment, including a description of special features of the proposed equipment which would facilitate learning and transfer of learning to the operational situation.

2. Requirements for long lead-times to develop the equipment, special installation and facilities requirements or technical problems associated with the equipment, and additional research required either to develop the equipment or verify its use.

Gross estimates of the type, quantity, and cost of training publications required by each system concept should also be included in the report.

BLOCK 4g - IDENTIFY TRAINING RESEARCH REQUIREMENTS

HFE Responsibility

Determined in HFE Block 3

Output

Report of training research required for each system concept

Summary

Review estimates of required training

Consider probable training equipment and facilities requirements

Identify training research requirements

Conduct research as required

The agency designated in HFE Block 3 begins this work in accordance with the QMDO Plan upon receipt of the estimates of required training (HFE Block 4d) and the estimates of required equipment and facilities (HFE Block 4f) for each system concept. These estimates are studied to determine the need for future training research which may be required during Advanced Development or later in the development process. It is also possible that requirements for such research may have been identified during the preparation of the Training Requirements Section of the HFE portion of the QMDO Plan (HFE Block 3c). The nature of this research will generally be to (1) refine proposed training concepts, and (2) verify the application of specific training to an operational system.

However, there may be other training research requirements identified at this time which have a direct bearing on the determination of cost-effective feasibility of a particular system concept. These research studies should be conducted during Exploratory Development under the scope of this block.

The final report of this block will identify that training research required by--but not yet performed for--each system concept under consideration. Manpower, time, and cost estimates will be included as well as a statement of interactions with other aspects of the project which may be required.

BLOCK 4h - DEVELOP PRELIMINARY SYSTEM DESIGN REQUIREMENTS

HFE Responsibility

Determined in HFE Block 3

Output

Report of HFE preliminary system design requirements

Summary

Review task allocation and environmental studies, and estimates of required training

Identify controls, displays, and equipment required to satisfy system performance requirements

Develop preliminary design requirements

The HFE agency designated in HFE Block 3 begins this work upon receiving reports of the function and task allocation studies (HFE Block 4a), environmental studies (HFE Block 4b), and the estimates of required training (HFE Block 4d). These reports, which identify the potential operational environment, the frequency and complexity of crew functions and tasks, as well as the relationship of these tasks to one another and to the proposed system hardware, provide information needed by the HFE design analyst to understand man's role during the operation, maintenance, and support of the proposed system concepts.

The HFE effort during this block consists of systematically reviewing the human functions and tasks required by each system concept, and identifying those controls, displays, and hardware configurations and concepts which provide the best man-machine interface and still meet the overall system mission requirements. This development of system and equipment requirements must be accomplished in collaboration with hardware engineers, designers, and personnel from other appropriate engineering disciplines, to provide the proper design trade-off balance and realism to the development process.

Tentative supersession, para 3, page 31 (16 Apr 69)

Another consideration in the formulation of preliminary design requirements is the degree to which equipment configuration can facilitate training of and learning by the equipment operator. For example, a positive transfer of training (with the likelihood of a resultant increase in human performance reliability and/or decrease in training costs) may be achieved by adopting for the proposed system the configuration of operator controls and displays already in use (and found to be satisfactory) on other Army equipment. (Care should naturally be taken to assure that a configuration for a control or display is not copied exactly from another system unless the meaning of that configuration is to remain the same.) However, it should be pointed out that, in equipment design, optimization from the standpoint of the man-machine interface is not necessarily the same as optimization from the standpoint of training. There may be occasions when it is appropriate to perform a trade-off analysis or to effect a compromise between the two standpoints.

Typical of man's basic characteristics which must be considered during the design requirements development process are:

a. Sensory and perceptual capacities

b. Motor skills, mobility, coordination and muscle strength

c. Information processing and decision-making abilities

d. Group communications and man-man interactions

e. Anthropometric requirements

f. Performance capabilities under conditions of stress, fatigue, and unusual environments.

Emphasis should be given to identifying human performance required by operators, and maintenance and support personnel for each system design, to identifying potential human errors, and to identifying that human performance which is critical to system performance or safety.

It should be pointed out that equipment which has been designed to provide the optimum man-machine compatibility during the operational situation may not be the design which enables the optimum learning of operational and maintenance functions. Therefore, wherever possible, the design concepts considered should include approaches which will facilitate learning by the Army personnel who will be trained to operate and maintain the system. For example: (1) A positive transfer of learning may be achieved by standardizing the design of certain operational control/display panels for a proposed system with those of other Army systems having similar functions; (2) previously demonstrated ease of learning may provide the basis for selecting one control/display configuration over another.

The effort in this block must be considered critical, as it is not only the first opportunity for HFE to make an input directly concerned with design, but also the foundation for subsequent HFE design efforts throughout the development process.

BLOCK 5 - HFE INPUTS TO PARAMETRIC DESIGN STUDIES

HFE Responsibility

HFE Concept Team

Output

HFE portion of Parametric Design Studies

Summary

Review HFE Exploratory Development

Collate significant findings

Prepare HFE portion of Parametric Design Studies

When the HFE Exploratory Development Research (HFE Blocks 4a-h) has been completed, the HFE Concept Team meets to review the work and collate the significant findings. Significant findings are those which

a. Determine or contribute to the determination of whether or not a particular system concept is feasible from an HFE standpoint.

b. Make important contributions to defining the broad band(s) of technically feasible approaches for obtaining the capabilities expressed in the QMDO.

The HFE Concept Team prepares and forwards to the QMDO developing agency a summary of the significant HFE findings to be included in the Parametric Design Studies. Where these findings have implications beyond human factors engineering (such as system cost, size, or weight), the implications will be explained.

BLOCK 6 - PREPARE HFE INPUT TO QMA

HFE Responsibility

HFE Concept Team

Output

HFE input to QMA

Summary

Review Parametric Design Studies

Consider Mission and Performance Envelopes

Determine HFE advantages and disadvantages of each technical approach

Recommend technical approach most satisfactory from HFE standpoint

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The HFE Concept Team reviews the technically feasible approaches described in the Parametric Design Studies (LCMM Block 22) in light of the limitations imposed by the Mission and Performance Envelopes (LCMM Block 23). After assuring that they understand the refined QMDO, the team members then revise the technically feasible approaches as necessary and list the HFE advantages and disadvantages of each.

The team then prepares a document to assist the developing agency in determining which one(s) of the feasible approaches to satisfying the QMDO is (are) preferable strictly from the technological point of view. The document, portions of which may later be incorporated into the QMA, clearly indicates the HFE requirements and implications of each approach. These requirements and implications include such considerations as: time to develop, support sub-systems and services required, cost of operation (both manpower and funds), technological risks, and comparison with existing equipment and systems.

BLOCK 7 - PREPARE HFE INPUT TO ADVANCED DEVELOPMENT PLAN

HFE Responsibility

HFE Concept Team

Output

HFE portion of ADP

Summary

Review system concepts selected for advanced development

Consider state-of-the-art

Prepare HFE portion of ADP (if appropriate)

Following approval of the proposed ADO by DA, the HFE Concept Team meets to consider inputs to the Advanced Development Plan which is submitted to OCRD by the developing agency. The purpose of advanced development is to clarify cost, operational, or technological factors pertaining to technically feasible approaches to satisfying the ADO. Ordinarily, more than one technical approach is carried into advanced development so that, by LCMM Block 38, an adequate fund of information will exist on which to base the selection of the single approach to be developed further.

The HFE Concept Team reviews those technical approaches and their attendant system concepts selected for advanced development and then considers the present state-of-the-art to determine whether or not any HFE efforts are required. Two alternatives are open:

a. Determine that the state-of-the-art is so advanced (or that the materiel end item is so simple) that HFE effort will not be required in Advanced Development (go directly to HFE Block 9). If this alternative is selected, the team must insure that at this time sufficient information is available to prepare the HFE input to the Proposed System Development Plan (HFE Block 11).

b. Determine that there are operational, technological, or cost factors pertaining to one or more of the system concepts being considered which require HFE effort during advanced development. If this alternative is selected, the team then prepares a comprehensive plan for the work which will

(1) Outline a systematic and preferably quantitative method by which the alternative ADO system concepts can be compared.

(2) Assure that all manpower characteristics (such as personnel skills, training requirements, behavioral reactions, human performance, anthropometric data, biomedical factors, safety engineering, etc.) are considered.

(3) Describe the general nature of the required research.

(4) Provide specific guidance for the conduct of each research task levied by the HFE Support Team.

(5) Provide manpower, time and cost estimates.

(6) State interactions with other aspects of the project which may be required.

(7) Describe the data collection methods to be used and the methods and times for reporting results.

In some cases the developing agency may request that the HFE portion of the ADP be submitted on DD Form 1498 (see AR 705-27). Use of this form does not, however, relieve the HFE Concept Team of the responsibility for planning all of the elements in subparagraphs (1) through (7) above.

BLOCK 7a - MAN-MACHINE SYSTEM REQUIREMENTS

HFE Responsibility

Determined in HFE Block 7

Output

Man-Machine System Requirements Section of HFE portion of Advanced Development Plan

Summary

Review system concepts selected for advanced development

Identify information gaps

Plan manpower, cost and schedule

Designated members of the HFE Concept Team review the system concepts selected for advanced development. The present knowledge of each system concept (usually that gathered during Exploratory Development) is studied with respect to that HFE knowledge applicable to the system concept to determine whether sufficient information exists from which to prepare those sections of the Proposed System Development Plan outlined in HFE Block 11a.

If sufficient information does not exist, information gaps (i.e., problem areas or aspects of a system concept which require cost, operational or technological clarification) are identified, and the work described in the appropriate block(s) (HFE Blocks 8a, b, c, f, g, j, and m) is scheduled.

Planning for the accomplishment of the work in the blocks selected will be in accordance with the outline in HFE Block 7.

BLOCK 7b - PERSONNEL REQUIREMENTS

HFE Responsibility

Determined in HFE Block 7

Output

Personnel Requirements Section of HFE portion of Advanced Development Plan

Summary

Review system concepts selected for advanced development

Identify information gaps

Plan manpower, cost, and schedule

Designated members of the HFE Concept Team review the system concepts selected for advanced development. The present knowledge of each system concept (usually that gathered during Exploratory Development) is studied with respect to the Army's personnel system to determine whether it would be possible at this time to prepare the personnel support plan section of the Proposed System Development Plan (HFE Block 11b).

If sufficient information does not exist, information gaps (i.e., problem areas or personnel aspects of a system concept which require cost, operational or technological clarification) are identified and the work described in HFE Blocks 8d and k is scheduled.

Planning for the accomplishment of the work will be in accordance with the outline in HFE Block 7.

BLOCK 7c - TRAINING REQUIREMENTS

HFE Responsibility

Determined in HFE Block 7

Output

Training Requirements Section of HFE portion of Advanced Development Plan

Summary

Review system concepts selected for advanced development

Identify information gaps

Plan manpower, cost, and schedule

Designated members of the HFE Concept Team review the system concepts selected for advanced development. The present knowledge of each system concept (usually gathered during Exploratory Development) is studied with respect to the Army's training programs to determine what aspects of the proposed training program(s) require cost, operational or technological clarification.

Information gaps (especially those requirements for additional research listed in HFE Block 4g) will be identified, and the work described in the appropriate block(s) (HFE Blocks 8e, h, l, and n) scheduled.

Planning for the accomplishment of the work in the blocks selected will be in accordance with the outline in HFE Block 7.

BLOCK 7d - TESTING REQUIREMENTS

HFE Responsibility

Determined in HFE Block 7.

Output

Testing Requirements section of HFE portion of Advanced Development Plan

Summary

Review system concepts selected for advanced development

Considor Mission and Performance Envelopes

Determine extent of HFE test requirements

Plan manpower, cost, and schedule

Designated members of the HFE Concept Team review the system concepts selected for advanced development, the Mission and Performance Envelopes and, if available, the reports of HFE Exploratory Development (HFE Blocks 4a thru h). Test proposals are solicited from participating HFE agencies and are developed into a draft test plan prepared in accordance with paragraph 14b, Section III, AR 70-10. This draft is then coordinated with each participating agency to insure adequacy and congruence of testing effort. Only after the draft plan has been approved by all participating agencies is it prepared in final form. Although the plan aims to cover all of the HFE testing to be conducted during Advanced Development, it often happens that additional test requirements are discovered in the course of other advanced development efforts. Consequently, the plan prepared at this time should provide for this contingency. The plan should also:

1. Identify the specific human performance to be tested.

2. State the specific test criteria, methods, and procedures to be used.

3. List the type(s) of data to be collected and describe in general the technique(s) for collecting it.

4. Specify the personnel required.

5. Designate the test site or facility, its location, and the agency responsible for conducting the test.

6. Provide for data reduction and analysis and identify the use to be made of test results.

BLOCK 8 - HFE ADVANCED DEVELOPMENT

HFE Responsibility

HFE Concept Team

Output

Technical reports

Summary

Perform HFE research and tasks outlined in ADP.

Provide HFE inputs to Trade-Off Determination and PQQPRI

When the Advanced Development Plan has been approved by DA, that HFE work described in the ADP (HFE Block 7) is begun. Each Army HFE agency which is participating in this work will appoint at least one representative to the HFE Concept Team. This representative will keep the team informed of the progress of his agency's work and the research findings. Coordination of HFE efforts among the participating agencies will be made at this team level.

The focus of the work during Advanced Development is in defining and refining the proposed system concepts to the extent that enough information is available on which to base the selection (in LCMM Block 38) of one technical approach, or one specific system concept employing that technical approach, to be developed further. Although the complexity of the proposed systems will shape the specific research questions to be answered, the general criterion question is "Can we make a reasonable estimate of the performance and the requirements (materiel, manpower and cost) of this system?"

The time span of Advanced Development varies widely among projects--depending upon the goal of the ADO and the extent of research scheduled. Consequently, the HFE Concept Team must maintain close liaison with the developing agency to insure the timely submission of HFE input to the Trade-Off Determination and PQQPRI (LCMM Blocks 32 and 34). Information produced in HFE Blocks 8a, b, c, f, g, j and m should

influence the Trade-Off Determination, and information from HFE Block 8k should influence the PQQPRI. While it is unnecessary for the final reports of the supporting HFE work to be completed when these two inputs are made, it is important for the work to have progressed far enough so that meaningful information is available.

BLOCK 8a - PERFORM ADDITIONAL FUNCTION AND TASK ALLOCATION STUDIES

HFE Responsibility

Determined in HFE Block 7

Output

Report evaluating possible sets of functions and tasks for each system concept

Summary

Review Mission and Performance Envelopes

Consider Parametric Design Studies as appropriate

Determine possible sets of man-machine functions and human performance tasks for each system concept

Indicate advantages and disadvantages of each set of functions and tasks

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The agency designated in HFE Block 7 begins these studies in accordance with the ADP upon instructions from the HFE Concept Team. These studies are similar in form to those described in HFE Block 4a, but are more thorough and detailed. The HFE agency reviews the Mission and Performance Envelopes to insure understanding of the various system concepts under consideration, and considers pertinent research findings from the Parametric Design Studies. The agency then determines the possible sets of man-machine functions which will satisfy each system concept and describes the human performance tasks in each set.

The ultimate purpose of the work in this block is to identify the most advantageous and desirable set(s) of functions which can be allocated to man in each system concept. These sets of functions must not only be reasonable when each of the specific tasks required to accomplish the function is considered by itself; care must be taken to insure that, if a human operator is expected to perform a number of tasks

either simultaneously or sequentially during the accomplishment of a mission, either (1) he can indeed perform those tasks simultaneously or sequentially without degrading total system performance, or (2) the necessary equipment redesign or function reallocation can be accomplished to facilitate the simultaneous or sequential performance of the tasks.

Depending upon the complexity and novelty of the system concepts, identification of the desired set(s) may be accomplished simply by lists or functional flow diagrams; or it may be necessary to conduct formal studies employing troops, simulated equipment and special environments (such as those studies conducted in HFE Block 8i). Following whatever effort is required, the HFE agency indicates the advantages and disadvantages of each set of functions determined for each system concept.

BLOCK 8b - PERFORM ADDITIONAL ENVIRONMENTAL STUDIES

HFE Responsibility

Determined in HFE Block 7

Output

Report of human performance in likely environments for each system concept

Summary

Review Mission and Performance Envelopes

Consider Parametric Design Studies as appropriate

Assess effect of environmental influences on human performance

Indicate any requirements for special individual characteristics

---

The agency designated in HFE Block 7 begins these studies in accordance with the ADP upon instructions from the HFE Concept Team. These studies are similar in form to those described in HFE Block 4b, but are more thorough and detailed. The HFE agency reviews the Mission and Performance Envelopes to insure understanding of the various system concepts under consideration, and considers pertinent research findings from the Parametric Design Studies. The report of the initial allocation studies (HFE Block 4a) and/or an interim report from the present allocation studies (HFE Block 8a) is/are studied to determine the range of functions and tasks which might be assigned to human operators.

Studies are then conducted which obtain and evaluate quantitative data concerning human performance of those functions and tasks in the likely environmental situations created by the various modes of

system operation. Decrements in human performance which can be attributed to environmental influences will be identified and described quantitatively where appropriate. Care will be taken throughout the studies to determine whether human performance on a given task is enhanced by any individual physiological or psychological characteristics (e.g, 20/20 vision, above average intelligence, etc.). If so, the task and related characteristic(s) will be explained in the final report.

BLOCK 8c - DETERMINE PRELIMINARY SAFETY REQUIREMENTS

HFE Responsibility

Determined in HFE Block 7

Output

Report of potential system hazards, and system safety design requirements for each system concept

Summary

Review Mission and Performance Envelopes and system concepts

Review allocation and environmental studies

Identify system hazards and determine safety design requirements for each system concept

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The agency designated in HFE Block 7 initiates this work in accordance with the ADP by reviewing the system concepts selected for advanced development. The system performance criteria determined from the Mission and Performance Envelopes, as well as the data generated during HFE Blocks 8a and b, should be carefully studied to understand the total role of man in operating, maintaining, and supporting the subsystems and equipment associated with each system concept.

The objective of the work of this block is to determine, in as much depth as possible, what potential safety hazards exist within each system concept, and to determine what safety design measures would be necessary to neutralize these potential hazards. This information, when considered with all other information generated during Advanced Development, helps provide a basis for selecting the one system concept which should undergo further development.

However, all system safety problems cannot be resolved through the design of the system alone. Maximum system safety can only be

achieved through the application of a realistic safety program. The primary effort regarding a safety program at this point in the development cycle is to:

a. Structure a safety program plan which, among other things, identifies the organizational and management responsibilities, safety engineering activities, milestones, analysis and testing, data reporting, etc., during the development cycle of each proposed system concept.

b. Conduct a preliminary safety analysis of the subsystems and hardware which interface with man during the operation, maintenance, and support of each system concept.

c. Structure that portion of the training program requirements required for safety education.

d. Estimate the cost factors, manpower and facilities required to execute the safety program for each proposed system concept.

Although the work of this block is the primary safety effort during Advanced Development, other work (HFE Blocks 8a, b, f, and g) may provide useful system safety inputs. This apparent overlap (which should be encouraged rather than discouraged) is caused by the fact that all HFE effort in Advanced Development is concerned with man as a system component. However, the major difference in effort here is one of emphasis. The bulk of the HFE effort is fundamentally concerned with total system effectiveness, but in the course of that work situations are frequently uncovered which are potentially hazardous; the work in this block, on the other hand, is primarily concerned with the identification and correction of hazardous situations caused by human error, materiel failure, or poor design.

The reader is directed to AFSC DH 1-6, System Safety, which is an excellent reference concerning system safety analysis techniques.

BLOCK 8d - PERFORM PERSONNEL RESEARCH

HFE Responsibility

Determined in HFE Block 7

Output

Report of personnel research studies

Summary

Review allocation and environmental studies

Consider Parametric Design Studies as appropriate

Perform personnel research studies

The agency designated in HFE Block 7 begins this work in accordance with the ADP upon receipt of data from the allocation and environmental studies (HFE Blocks 8a and b). The purpose of the effort here is to insure that all of the information is available which will be required to prepare the summary of personnel requirements (HFE Block 8k) and which may later serve as the basis for the preparation of other required personnel estimates.

There are two general categories of research studies which may be performed in this block. The first category consists of those studies first proposed in HFE Block 4e which are usually concerned with refinements to the Army's personnel selection system. The second category consists of those studies which are a direct outgrowth of unanticipated findings produced by the allocation or environmental studies. An example in this category would be a report by an allocation study in which troops were used that a specific maintenance task was performed reliably only by troops with GT scores above 127. A personnel research study might now be required to determine the nature and extent of the trait(s) which is (are) critical to the performance of such a task.

BLOCK 8e - REVISE ESTIMATES OF REQUIRED TRAINING

HFE Responsibility

Determined in HFE Block 7

Output

Report of estimated training requirements for each system concept

Summary

Review estimates of required training generated during Exploratory Development

Revise or develop training program concepts and training requirements

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The agency designated in HFE Block 7 begins the work of this block in accordance with the ADP. The effort here is similar to that described in HFE Block 4d, but is more thorough and detailed, and is concerned with revising and finalizing the estimates of required training for each system concept.

The development of training requirements is an iterative process. Thus, as more specific and accurate information is generated as to what tasks man will be required to perform in a system, and what skills and knowledge must be learned or acquired to accomplish those tasks (HFE Blocks 8a-d, f, g), the preliminary training program concepts and training requirements developed during exploratory development must be modified and revised.

If Exploratory Development did not precede this phase, these training program concepts and training requirements (as discussed in HFE Block 4d) must be generated during this effort.

In either case, sufficient information about total training costs must be accumulated to provide a basis by which the system concepts can be compared quantitatively, and an ultimate decision made as to which system concept should undergo further development.

Throughout the work of this block, note should be made of any requirements for training research which may be needed to clarify specific training approaches, human learning data, or specific training problems or development risks. These requirements provide a significant input to HFE Block 81 where training research is performed.

BLOCK 8f - PERFORM RELIABILITY STUDIES

HFE Responsibility

Determined in HFE Block 7

Output

Report estimating human performance reliability for each system concept

Summary

Review Mission and Performance Envelopes and system concepts

Examine results of allocation and environmental studies

Determine potential sources of human error

Explore methods for improving human performance reliability

Total estimated system reliability is an important consideration in the final selection of the system concept to be adopted. It is therefore necessary to form some estimate of the maximum reliability which can be expected in the human performance portion of the system. Before this estimate can be attempted, it is necessary to insure that the latest technology and state-of-the-art has been brought to bear on the man-machine interface so that man's performance is helped--not hindered--by the machinery he manipulates.

The agency designated in HFE Block 7 begins this work in accordance with the ADP by reviewing the Mission and Performance Envelopes and those system concepts undergoing advanced development. The results of the function and task allocation studies and environmental studies (HFE Blocks 8a and b) are examined to determine what human performance is required under what circumstances. In particular, the man-machine interfaces are examined to determine possible sources of human error.

Studies are then conducted as necessary to establish the sources of human performance errors, and to discover methods of improving system reliability by minimizing the occurrence and effect of such errors. Examples of these methods include design or configuration requirements, special training courses, and monitoring devices.

The final report of these studies will include a comparative estimate of human performance reliability among the contending system concepts.

BLOCK 8g - PERFORM MAINTAINABILITY STUDIES

HFE Responsibility

Determined in HFE Block 7

Output

Report estimating maintainability of each system concept

Summary

Review Mission and Performance Envelopes and system concepts

Examine allocation and environmental studies

Determine problem areas of system maintainability

Explore methods of overcoming problems

Maintenance characteristics such as frequent long down times, expensive and exotic tools, lengthy training requirements for maintenance personnel, and difficult maintenance tasks can generally overcome the advantages of an otherwise appealing system proposal. Accordingly, an estimate should be made of the overall maintainability of each of the contending system concepts. Before this estimate is made, however, the latest technology and state-of-the-art should be applied to the maintenance proposals in each system concept. This will insure that the actual maintenance requirements being evaluated are the minimum which will be necessary at each maintenance level.

The agency designated in HFE Block 7 begins this work in accordance with the ADP by reviewing the Mission and Performance Envelopes and the system concepts undergoing advanced development. The results of the function and task allocation studies and environmental studies (HFE Blocks 8a and b) are examined to determine what human performance maintenance tasks will be required under what probable circumstances.

Studies are then conducted as required to determine methods for reducing where possible the number of separate human maintenance

tasks required, and to insure that those tasks which are required to be performed as simply and expeditiously as possible. Examples of these methods include requirements for modular design at certain places in the system, specification of hardware compatible with the present issue of tools, and positioning the subassemblies requiring frequent maintenance in easily accessible places in the system.

The final report of these studies will include a comparative estimate of the maintainability of the contending system concepts.

BLOCK 8h - REVISE TRAINING EQUIPMENT AND FACILITIES REQUIREMENTS

HFE Responsibility

Determined in HFE Block 7

Output

Report of estimated requirements for training equipment and facilities for each system concept

Summary

Review estimates of required training equipment and facilities generated during Exploratory Development

Review estimates of required training

Revise or develop requirements for training and equipment facilities

---

The agency designated in HFE Block 7 begins the work of this block in accordance with the ADP upon receipt of the estimates of required training produced in HFE Block 8e. The effort here is similar to that described in HFE Block 4f, but is more thorough and detailed, and is concerned with revising and finalizing the estimates of training equipment and facilities required by each system concept.

If Exploratory Development did not precede this phase, the estimates of required training equipment and facilities (as discussed in HFE Block 4f) must be generated during this effort.

The fundamental information needed to develop or modify training equipment and facilities requirements is generated during the course of the work described in HFE Blocks 8a-e. These data allow the identification of those tasks, skills, and knowledges which must be learned or acquired by the operational, maintenance, and support personnel of the various system concepts, the types of training which are feasible, and the proficiency levels which the trainees must achieve.

The training objectives (i.e., the tasks, skills, and knowledges to be learned or acquired) are the basis from which training equipment and facilities requirements are structured. Each training objective must be examined to determine the possible training methods which may be employed to bring about the desired skill or knowledge. Accumulated training experience is then used to determine the type of training or the mix of training and training equipment needed to achieve the operational proficiency required. Where experience is not sufficient to make this determination, the need to perform training research (HFE Block 81) may be identified.

Because the costs of required training equipment and facilities may represent a major factor in the selection of one system concept over another, it is imperative that these costs be determined as an integral part of the effort of this block. It is important to remember that these costs consist of not only development and production costs, but also installation and operating costs, and that these costs can be substantially affected by the degree to which existing equipment and facilities can be utilized for the proposed training.

Special emphasis should be placed on identifying those requirements for training devices having potentially long lead times.

BLOCK 8i - CONDUCT TESTS SUPPORTING ADVANCED DEVELOPMENT

HFE Responsibility

Determined in HFE Block 7

Output

Report of testing conducted to provide clarifying information on cost, operational, or technological aspects of system concepts

Summary

Review HFE testing requirements outlined in ADP

Review requirements for testing identified during conduct of Advanced Development

Conduct appropriate tests

The agency or agencies designated in HFE Block 7 initiate(s) this work in accordance with the ADP by reviewing the testing requirements specified in HFE Block 7d. It is also very possible that some requirements for test support will not have been foreseen, but rather will evolve as the advanced development effort described in HFE Blocks 8a-h is carried out.

The work accomplished during this block has one overall objective--to conduct the necessary testing to support the work of advanced development and thereby help provide the information necessary to clarify cost, operational, or technological aspects of each system concept undergoing advanced development. The data from these tests provide a needed realism to the estimates of man-machine performance expected from the proposed system concepts, and therefore a better base from which to generate system design requirements (HFE Block 8j).

An example of the kind of testing conducted here follows: During the development of a tank system concept it was postulated that,

because of an assumed limited ability of a crewman to load the main gun while the tank was moving, the gunner could easily require more ammunition than could be supplied by the crew. This situation might seriously limit the firepower of the total system. However, before extensive work was undertaken to solve the problem, it was decided to verify the existence of the problem. Tests were conducted using dynamic mockups of the proposed system. These tests showed that, in fact, the loader could easily stay ahead of the gunner's firing needs and that the real difficulty centered around acquiring targets rapidly and laying the gun on the target. As a result of this testing, design problems in the tank's proposed optical and weapon systems were uncovered as barriers or risks to system success which would influence development time, total cost, and operational capability--information which could significantly affect the decision as to which system concept should proceed to contract definition.

BLOCK 8j - REVISE PRELIMINARY SYSTEM DESIGN REQUIREMENTS

HFE Responsibility

Determined in HFE Block 7

Output

Report of HFE system design requirements and design trade-off considerations

Summary

Review reports from safety, reliability, and maintainability studies, and HFE testing

Review preliminary HFE system design requirements generated during Exploratory Development

Revise or generate HFE system design requirements

The agency designated in HFE Block 7 begins this work in accordance with the ADP by reviewing the output from all the HFE effort conducted thusfar in Advanced Development (HFE Blocks 8a-i). Particular attention should be paid to the effort conducted during the safety, relaibility, and maintainability studies (HFE Blocks 8c, f, and g, respectively) to determine what applicable system design requirements were generated there. The results of the testing conducted in HFE Block 8i are also a potentially important input here.

The work in this block is very similar to that described in HFE Block 4h, but is more detailed and is concerned with revising and finalizing HFE system design requirements for each system concept. Emphasis is placed on collecting and collating data which can clarify development risks, design differences, and other design trade-off information necessary to help make a decision as to which system concept should proceed to contract definition.

BLOCK 8k - PREPARE SUMMARY OF PERSONNEL REQUIREMENTS

HFE Responsibility

Determined in HFE Block 7

Output

Report summarizing personnel requirements for each system concept

Summary

Review system concepts and Mission and Performance Envelopes

Examine results of allocation, environmental and personnel research studies

Prepare summary of personnel requirements

The agency designated in HFE Block 7 begins this work in accordance with the ADP by reviewing the system concepts being given advanced development and the Mission and Performance Envelopes. The summary of personnel requirements may then be prepared in one of two general ways: (1) updating and refining the estimate of personnel requirements produced in HFE Block 4c, or (2) determining personnel positions directly from data produced in the allocation studies of HFE Block 8a. Which alternative is selected will depend largely on system complexity and the present applicability of the original allocation studies.

Results of the personnel research studies and estimates of required training (HFE Blocks 8d and e, respectively) will be examined to insure that the required individual skills, aptitudes and special characteristics are established for each personnel position required for operation, maintenance, and support of each proposed system concept.

A summary of personnel requirements will then be prepared for each system concept under consideration. Although the format for this summary will vary, it will include as a minimum that information described in Chapter 3 of AR 611-1, and will be structured so as to provide a meaningful input to LCMM Block 34 (PQQPRI).

BLOCK 81 - PERFORM TRAINING RESEARCH

HFE Responsibility

Determined in HFE Block 7

Output

Report of training research studies

Summary

Review requirements for training research identified during Exploratory Development

Review estimates of required training and training equipment and facilities requirements

Perform training research studies

Identify future training research requirements

The agency designated in HFE Block 7 begins this work in accordance with the ADP. The need for training research comes from two basic sources: Those training research requirements identified during Exploratory Development (HFE Block 4g) and restated or revised in the ADP (HFE Block 7c); and those requirements for research uncovered during the course of revising the estimates of required training (HFE Block 8c) and revising the training equipment and facilities requirements (HFE Block 8h).

The research conducted here should be either oriented toward obtaining immediate training information to help differentiate one system concept from another, or aimed at defining the future research which may be required during subsequent development of each system concept to overcome known problems relative to the proposed training concepts or equipment.

In any case, the primary product of this research should be that information, relative to training, needed to help make a decision as to which system concept should proceed to contract definition.

Examples of typical training research which may be performed within the purview of this block are as follows:

a. Studies to determine human performance levels achieved using new training approaches and/or new equipment.

b. Analytical studies to determine cost-effective factors involved in achieving specific training goals.

BLOCK 8m - DEVELOP TRAINING EQUIPMENT DESIGN REQUIREMENTS

HFE Responsibility

Determined in HFE Block 7

Output

Report of HFE training equipment design requirements

Summary

Review estimates of required training, training equipment requirements, and system design requirements

Generate HFE training equipment design requirements

The agency designated in HFE Block 7 begins this work in accordance with the ADP by reviewing the estimates of required training (HFE Block 8c), the training equipment and facilities requirements (HFE Block 8h), and the system design requirements (HFE Block 8j). This is done to (1) acquire an understanding of the role of man in operating, maintaining, and supporting the subsystems and equipment associated with each system concept, (2) become aware of the training requirements and training programs envisioned for each system concept, (3) understand what training equipment is required by, and proposed for, each system concept.

The work of this block consists of establishing, for each training equipment end item required by each system concept, a set of HFE design requirements. These design requirements should specify, in as much detail as possible, the degree to which each end item should possess the following training equipment effectiveness characteristics:

a. Physical realism and fidelity. Degree to which the end item must physically resemble the actual equipment (overall size, shape, color; operating characteristics of controls and displays; etc.).

b. Control response realism and fidelity. Degree to which information displays or operational environment must respond to activation of controls by trainee.

c. Operational environment realism and fidelity. Degree to which operational environment must be represented or simulated in training environment.

d. Function and task coverage. What operational situations (including unusual or crisis situations) must be presentable to the trainee, and what functions and tasks he must be able to execute to react to the situations presented.

e. Information display realism and fidelity. Degree to which information displays (including "real world" fields of view) in training environment must resemble those in operational environment.

f. Information feedback availability and fidelity. Amount and type of information required to be provided trainee as to adequacy of his responses.

g. Programability. Degree to which end item can be programmed to present operational situations to trainee.

These training equipment design requirements must be established to insure that the degree of realism and fidelity of training required of each training equipment end item is achieved. They also provide an additional base for estimating the costs associated with securing the training equipment required by each system concept, and for clarifying development risks, design differences, and other trade-off data needed to help make a decision as to which system concept should proceed to contract definition.

BLOCK 8n - DETERMINE TRAINING PUBLICATIONS REQUIREMENTS

HFE Responsibility

Determined in HFE Block 7

Output

Report of estimated requirements for training publications for each system concept

Summary

Review estimates of required training and requirements for training equipment

Develop training publications requirements

The agency designated in HFE Block 7 begins this work upon receipt of the estimates of required training (HFE Block 8e) and the report of requirements for training equipment (HFE Block 8h). Results of the training research conducted in HFE Block 81 should also be studied, as appropriate. The effort here consists of determining the requirements for equipment publications, operating and maintenance manuals and other training documents required by each system concept if it were to become operational.

The AR 310 series should be consulted regarding the types of documents normally required and lead time and distribution requirements. The final report of this block should reflect, for each system concept, the type and number of publications required, their application to training, and a general estimate of the costs of preparing and publishing the documents.

The primary function of publications in an operational Army system is to support the training of personnel and/or to support the performance of trained personnel on the job. These documents furnish specific technical direction and information for the operation, maintenance, inspection, modification, and storage of Army materiel, and are usually considered "job performance aids" which may function both as data storage and display devices.

Accordingly, the development of publications can be viewed as a design problem of displays, in which the objective is to provide the information required by the user in the most effective and usable form. Publication requirements should, therefore, include that HFE effort required throughout the publication development period to insure that the information content of the publications reflects the state-of-the-art in information processing.

BLOCK 8o - DETERMINE FUTURE HFE TEST AND EVALUATION REQUIREMENTS

HFE Responsibility

Determined in HFE Block 7

Output

Report of requirements for HFE participation in future testing and evaluation for each system concept

Summary

Review reports of tests previously conducted during advanced development

Study HFE system design requirements

Develop requirements for future HFE testing and evaluation

The overall objectives of HFE testing and evaluation are:

a. To assure that the total system design is studied and evaluated to assess the compatibility of men and equipment as they interact in the operational situation.

b. To provide a feedback as to the validity of earlier HFE decisions regarding system and equipment design, and early estimates of manpower and training requirements.

c. To support system and hardware development by:

(1) providing information regarding human performance limits, efficiency, and safety;

(2) providing the man-machine performance data necessary to optimize controls, displays, and environment required by man in the system;

(3) determining the degree to which contractor HFE applications are technically adequate and comply with applicable directives, standards, and specifications.

The primary purpose of the work in this block is to estimate the manpower, time, facilities, and costs required for HFE participation in the series of tests to which the selected system concept will be subjected. This is done because it is conceivable that the various competing system concepts would require significantly different amounts of HFE test and evaluation effort. This information helps form a basis for selecting one system concept over another to proceed to contract definition.

The agency designated in HFE Block 7 begins this work in accordance with the ADP by reviewing the reports of that testing already conducted in support of advanced development (HFE Block 8i), and studying the report of HFE system design requirements (HFE Block 8j) to determine what testing has been accomplished thus far, and what requirements for testing are as yet unmet. It should be remembered that the most important tests and evaluations from an HFE viewpoint are those performed early in the development cycle. Data from these early tests have a higher probability of influencing the design, personnel, and training concepts of the system than data obtained later in the development process. Usually, if the HFE input to the design is not accomplished by the Engineering Design Test, very few if any significant changes can be made.

The final report of this block will indicate the HFE requirements for the testing and evaluating of each system concept to include estimates of materiel, facilities, logistics support, personnel, and monetary requirements.

BLOCK 9 - PREPARE HFE ADVANCED DEVELOPMENT SUMMARY AND RECOMMENDATION

HFE Responsibility

HFE Concept Team

Output

Report summarizing HFE Advanced Development effort and recommending best technical approach from HFE point of view.

Summary

Review HFE advanced development

Collate significant findings

Determine HFE advantages and disadvantages of system concepts under consideration

Recommend the one technical approach or specific system concept superior from the HFE point of view

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Prior to the selection of the developer of the one technical approach or specific system concept to be adopted (LCMM Block 38), the HFE Concept Team meets to prepare the HFE recommendations and supporting data. The team either (1) reviews the reports from HFE advanced development or (2) if HFE advanced development was not conducted, reviews the fund of HFE information available on the various system concepts under consideration. Significant findings (those facts or data upon which inferences of advantage or disadvantage are based) are collated, and each system concept which will be considered in LCMM Block 38 is evaluated from the HFE standpoint.

The team then prepares a document to assist the developing agency in selecting the best technical approach for subsequent development. This document will ordinarily recommend one system concept as being superior from the HFE point of view. (In those instances in which

there are no significant differences from the HFE point of view among the contending systems, the HFE Concept Team will submit a negative report to the developer.) The advantages and disadvantages of the recommended concept and of all other concepts under consideration will be stated in comparative form so that, if the developing agency selects a concept other than the one recommended, the HFE implications and requirements of that selection are clear.

BLOCK 10 - PREPARE HFE INPUT TO PROPOSED QMR

HFE Responsibility

USACDC

Output

PQMR

Summary

Specify HFE requirements

Coordinate HFE inputs of participating agencies

Responsibility for adequate specification of HFE requirements in QMR's is assigned to USACDC by AR 602-1. Implicit in this assignment of responsibility is the coordination of the contributions from all of the agencies participating in previous HFE studies. Data generated during HFE Advanced Development (HFE Block 8) will be made available to USACDC and assistance will be provided from AMC HFE resources on an as-required basis.

BLOCK 11 - PREPARE HFE INPUT TO PROPOSED SYSTEM DEVELOPMENT PLAN

HFE Responsibility

HFE Concept Team

Output

HFE input to Proposed System Development Plan

Summary

Establish major HFE work requirements during system development

Prepare coordinated proposal for allocation of HFE work

Prepare specific plans for HFE work in contract definition

Prepare HFE input to Proposed SDP

After approving the Proposed QMR, Hq DA determines (by the criteria in AR 70-17) whether the system will be project managed and undergo contract definition, or whether the necessary management will remain with the developing agency and either Engineering Development or Operational System Development will be initiated. If the system is not to undergo contract definition, LCMM Blocks 44-93 and HFE Blocks 11-25 are omitted. (Go directly to HFE Block 26. If it has been decided that the system should be project managed, the "working task group" established by the first charter (LCMM Block 43) begins work on a proposed System Development Plan. At the same time, the HFE Concept Team meets to discuss and plan the HFE work required during system development.

Inasmuch as HFE (in the broad sense in which it is used here) influences many aspects of system development, there is no single "HFE section" of the SDP. Instead, there are HFE considerations which apply to many of the sub-plans described in Appendix D, AR 705-12. A primary task of the HFE Concept Team in accomplishing the work in this block is to

insure that these HFE considerations are included in the appropriate subplans regardless of what Army agency actually prepares them. To achieve the objective of total integration of manpower resources, it is imperative that the HFE considerations implanted in the SDP subplans have themselves been thoroughly coordinated among all HFE agencies. This coordination should be accomplished at the HFE Concept Team level.

After reaching a consensus on the general direction and focus of HFE efforts required, the HFE Concept Team members prepare a coordinated proposal for the allocation of HFE work required during contract definition and system development. The team then prepares plans for that work which must be accomplished during Contract Definition. These plans should:

a. Assure that all manpower characteristics (such as personnel skills, training requirements, behavioral reactions, human performance, anthropometric data, biomedical factors, safety engineering, etc.) are considered.

b. Describe the general nature of the required work.

c. Provide special guidance for the conduct of each task deemed necessary by the HFE Concept Team.

d. Provide manpower, time and cost estimates.

e. State interactions with other aspects of the project which may be required.

When the detailed plans are complete, preparation of the HFE inputs to the SDP subplans begins. The initial drafting of the Proposed SDP in LCMM Block 47 is for the purpose of securing authorization from the Secretary of Defense to continue the project. Consequently, the plan at this point is a shorter, more general document which usually summarizes the various subplans. Members of the HFE Concept Team conduct liaison as appropriate with the agencies responsible for the preparation of the various subplans. These agencies are then furnished with either the detailed HFE plans or summaries of them (the choice being made by the preparing agency). However, in the case of the Contract Definition Plan (which is another part of the Proposed SDP) the HFE Concept Team always provides the preparing agency (the "working task group") with a detailed plan for HFE effort during Contract Definition.

Although there is no single HFE section of the SDP in which all detailed HFE considerations and requirements are stated, the detailed plans prepared by the HFE Concept Team for inclusion and integration into the various subplans of the SDP should be summarized and collated into an HFE Program Plan. This plan will provide an overview of the HFE effort envisioned during Contract Definition and Development and Production, and will particularly serve as the foundation of the work in HFE Block 14.

BLOCK 11a - SYSTEM DESIGN AND DEVELOPMENT SUPPORT

HFE Responsibility

Determined in HFE Block 11

Output

HFE input for SDP

- Reliability Plan
- Maintainability Plan
- System and Sub-System Characteristics Plan
- Configuration Management Plan
- Facilities Plan
- Integrated Logistics Support Plan
- Contract Definition Plan

Summary

- Review previous system design and development efforts
- Determine nature and extent of HFE efforts required
- Coordinate requirements among HFE agencies
- Prepare plans or summaries as required

Designated members of the HFE Concept Team review previous design and development efforts on the selected system concept. They then determine, insofar as possible at this time, what HFE efforts and requirements applicable to the above plans should occur at what times during the period of contract definition. The efforts and requirements

determined will then be coordinated--first with other HFE agencies to insure complete integration of HFE work, and then with the agencies preparing each of the sub-plans listed above. The preparing agencies specify the format and degree of detail in which they wish the HFE input, and the team members prepare the information accordingly.

BLOCK 11b - SYSTEM PERSONNEL REQUIREMENTS

HFE Responsibility

Determined in HFE Block 11

Output

HFE input for SDP Personnel Support Plan

Summary

Review previous system personnel reports

Determine nature and extent of HFE efforts required

Coordinate requirements among HFE agencies

Prepare plans or summaries as required

Designated members of the HFE Concept Team review the previous personnel work performed on the selected system concept. They then determine, insofar as possible at this time, what personnel work should occur at what times during system development. Special attention will be given to work required during the period of contract definition. Work requirements will then be coordinated with all participating HFE agencies to insure complementary effort. Detailed plans for HFE work will be prepared where possible, and the appropriate information furnished to the agency preparing the SDP Personnel Support Plan.

An important HFE input to the Personnel Support Plan is a summary of the HFE task and skill analysis tasks to be performed or that have been performed to determine the personnel training and organizational requirements of the selected system concept.

BLOCK 11c - TRAINING PROGRAM PLANNING

HFE Responsibility

Determined in HFE Block 11

Output

IIFE input for

SDP Personnel Support Plan

SDP System and Sub-System Characteristics Plan

Five-Year New Equipment Training Program

Summary

Review previous system training reports

Determine future training requirements for trainer and developer

Coordinate requirements among HFE agencies

Prepare plans and inputs as required

The purpose of the work in this block is to initiate planning for the two major areas of training effort (that by the trainer and by the developer) which will be required as the selected system is developed and fielded. Designated members of the HFE Concept Team review previous training plans for the selected system concept and structure the anticipated training requirements of both trainer and developer. These requirements will then be coordinated with all participating HFE agencies to insure complementary effort.

The plans prepared in this block should outline the scope of training work to be accomplished during system development by both the trainer and the developer. Training blocks in the HFE Program Model for Contract Definition and Development and Production which are appropriate to the system being developed should be tentatively selected and desired completion times should be specified for each.

Generally, the trainer must understand the system concept itself well enough to generate training considerations peculiar to the system concept. The developer must then insure an understanding of these training considerations so that appropriate input can be made into system design. The developer will decide which training considerations generated by the trainer should be incorporated in the SDP System and Sub-System Characteristics Plan in HFE Block 21 when the SDP is updated.

Inputs to the SDP Personnel Support Plan should consist of:

a. Summary of HFE tasks to be performed or that have been performed to determine the training requirements of the selected system concept.

b. Summary of the training plan for providing qualified personnel for operation and support of the selected system concept.

Planning for the conduct of New Equipment Training (see AR 350-12) should also begin at this time, with the input for the Five-Year New Equipment Training Program being prepared in accordance with AMCR 350-6.

BLOCK 11d - TESTING AND EVALUATION

HFE Responsibility

Determined in HFE Block 11

Output

HFE input for SDP Coordinated Test Plan

Summary

Review previous HFE test and evaluation requirements developed in Advanced Development

Determine and coordinate HFE test requirements

Prepare HFE input for CTP

The purpose of the work in this block is to bring together for the first time in a planning document the coordinated test and evaluation requirements of all HFE agencies. These requirements, although stated generally at this time, will serve to alert management, contractors and other Army agencies concerned of the nature and extent of HFE testing envisioned. It is intended that the test plan prepared in this block will be revised and elaborated (see HFE Block 21d) before the actual testing begins.

Designated members of the HFE Support Team perform this work in one of two ways: (1) by updating and refining the test and evaluation estimate prepared in HFE Block 80 or (2) if HFE Advanced Development was not performed, by determining HFE test requirements directly from a study of the system concept itself. In addition, test requirements will be solicited from all HFE agencies participating in the project. Ordinarily, the major HFE work will be accomplished in the Engineering Design Test (see HFE Block 38); however, HFE participation should be scheduled if required in the other tests in the development cycle (see AR 70-10).

All HFE test requirements will initially be combined into one test plan which, by judicious coordination with participating HFE agencies, will permit derivation of essential information without unnecessary duplication of testing. This HFE test plan will follow the format specified in para 14b, Section III, AR 70-10.

BLOCK 12 - PARTICIPATE IN SYSTEM DEVELOPMENT PLAN IPR

HFE Responsibility

HFE Concept Team

Output

HFE briefing for IPR

Summary

Review results of previous work

Review HFE inputs to Proposed System Development Plan

Determine current status of project and problems

Propose HFE activities for Contract Definition

Prepare briefing for IPR

Provide HFE information and advice as required

The HFE Concept Team prepares for the IPR by reviewing all of the previous HFE effort, and studying the HFE inputs to the Proposed System Development Plan prepared in HFE Block 11. This is done so that the HFE representative(s) to the IPR will be in a position to discuss, and if necessary defend, the HFE inputs to the PSDP.

Prior to the IPR the HFE Concept Team determines the status of the project as being either "satisfactory" or "unsatisfactory" in each of the four general areas (design, personnel, training, testing). Significant problems are noted and, where possible, either solutions proposed or courses of action recommended. A short description should also be prepared indicating what responsibilities and activities the team contemplates during Contract Definition and subsequent development phases.

A formal briefing should then be prepared covering the above information. The team should insure adequate representation at the IPR to provide on-the-spot information or advice in any of the four HFE areas.

BLOCK 13 - PROVIDE HFE MANAGEMENT SUPPORT TO PROJECT MANAGER

HFE Responsibility

Designated by developing agency

Output

(continuing).

Summary

Establish HFE Support Team

Support Team coordinates HFE efforts supporting project manager

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At this stage in the Life Cycle Management Model the Project Manager has become the centralized management authority for the materiel development program. It is at the Project Manager level that all of the technological inputs to the program are coordinated. To insure that the HFE objectives contained in AR 602-1 are met with optimum efficiency, an HFE Support Team is constituted to provide management support to the Project Manager. The composition of this team will vary depending upon the nature of the project. An HFE agency--ordinarily the same one assigned the responsibility for HFE Block 2--reviews, in close coordination with the Project Manager's Office, the anticipated scope of HFE involvement during subsequent phases of system development.

As a result of this review, the HFE agency effects liaison with any Army agencies which were not represented on the HFE Concept Team and which may now be able to contribute to the project. The HFE Concept Team now disbands, and those team members who will remain with the project--plus any representatives from the other HFE agencies just contacted--form the HFE Support Team. If the Project Manager has an HFE staff, then at least one member of this staff should automatically become a member of the HFE Support Team.

Each representative to the HFE Support Team will keep the team informed of the progress of his agency's work, and will also insure that his own agency is kept abreast of the work of the HFE Support Team. Coordination of HFE efforts among the participating agencies will be made at this team level.

In general, the HFE Support Team responds directly to the Project Manager and has the following responsibilities:

a. Identifying and insuring timely programming and development of HFE objectives applicable to the project.

b. Developing and maintaining required documentation and reports for management and record purposes (e.g., HFE Program Plan produced in HFE Block 11).

c. Insuring that adequate financial support for HFE work is included in the formal planning documents.

d. Incorporating HFE requirements in contracts and work statements, as required, to obtain specified products and data on a timely basis.

e. Monitoring of required HFE work performed by contractors.

f. Collecting, coordinating and analyzing HFE information and data as it becomes available, determining the implications for the project of this data; and advising the Project Manager of pertinent developments and necessary changes.

g. Insuring by participation in IPR's and by liaison with other groups supporting the project that HFE activities and products are complementary to and compatible with other system development activities (e.g., data and configuration management, value and safety engineering, reliability and maintainability programs).

SECTION II

Contract Definition Phase

BLOCK 14 - PREPARE HFE INPUT TO RFP AND SELECTION PLAN

HFE Responsibility

HFE Support Team

Output

HFE input to RFP and Selection Plan

Summary

Review System Development Plan

Identify pertinent findings from Exploratory and Advanced Development

Determine HFE work requirements during Phase B

Estimate and outline HFE work requirements during development

Develop HFE criteria for proposal evaluation

Prepare HFE information and requirements package for RFP

Prepare HFE sections of selection plan

Update HFE Program Plan

Participate in bidders' conference

Following approval from DA or OSD to proceed with Contract Definition, the HFE Support Team--in accordance with instructions from the Project Manager--begins preparation of material for the RFP. The team members first review the System Development Plan to insure that they understand both the eventual goals of the program and its present state.

The HFE Support Team then reviews the reports of HFE Exploratory and Advanced Development. Information uncovered during those efforts which bears directly on the design or performance of the proposed system is stated in the form of system specifications. (In general, performance specifications are preferable to design specifications. Where design specifications are required, care should be exercised in the wording of the specifications in order to permit the contractor the widest possible design latitude within the necessary restriction.) In those cases in which testing will be the method used to determine whether or not the equipment produced by the contractor meets the specifications of the contract, test methods and standards will be stated (or referenced in the data package). Other information which is relevant and necessary for the contractor in the preparation of his proposals or which defines the parameters within which the Phase B trade-offs are to be made is included in the data package section of the RFP. (Where this information is too lengthy for direct incorporation in the RFP, clear statements of the location and pertinence of the information will be made in the references part of the data package.)

The team then determines what parts of the remaining HFE work (to include trade-off studies) should be accomplished during Contract Definition (Phase B) and what parts may be left until Engineering or Operational System Development. Additional criteria may be developed as appropriate, but two of the criteria for determining work to be done during Contract Definition are:

a. Are the results of this work likely to expand or reduce significantly the engineering concepts and alternatives now open to the contractors?

b. Are the results of this work likely to produce information which could be the basis for substantial alteration of a contractor's approach during later development?

Any work which meets those criteria is then specifically defined in a Work Statement for Contract Definition (Phase B). The form, general content and depth of information expected from the contractor as well as the time(s) and manner of reporting must be clearly stated. Remaining HFE work which can be envisioned at this time is outlined and included as appropriate in either the system specifications or data package sections of the RFP.

A requirement should also be made for the contractor to prepare a separate HFE plan (hereinafter referred to as the Contractor's HFE Plan) which will include, but not necessarily be limited to, discussion of:

a. schedules for performance of HFE related work

b. schedules for and methods of reporting data and results of work

c. cost estimates for a and b above

d. techniques to be employed in studies, experiments, and operational analyses

e. technical approaches to

(1) determining personnel requirements and selection procedures

(2) determining training and training equipment requirements

(3) HFE testing and evaluation

f. configuration management procedures to insure production and inclusion of HFE considerations in equipment design

The HFE Support Team should also strive to have included in the RFP--and, later, in the Phase B and development contracts themselves--provisions for incentives (usually cash) for the contractor whose work is devoid of HFE problems and errors. The wording of the contract provision(s) will vary with the work being described, but the objectives are (1) to insure contractor attention to HFE problems which will (2) result in a better system and (3) save the government the cost of buying design changes or living with unwieldy personnel or training requirements.

The team then prepares the HFE portions of the Selection Plan as follows:

a. A recommendation to the Source Selection Advisory Council (SSAC) for HFE representation on the SSEB: The recommendation will state the number of HFE members of the Source Selection Evaluation Board (SSEB) considered appropriate to handle the

estimated volume of HFE-related material requiring evaluation. The recommendation may propose candidates by name for the HFE positions on the Board or may stipulate requirements for those positions (in addition to those contained in Appendix 1, AMCP 715-3).

b. HFE criteria for proposal evaluation: Two sets of HFE criteria for proposal evaluation are prepared: the first will apply to the evaluation of proposals for Phase B work and the second to the evaluation of proposals for the development contract. The formulation and statement of both sets of criteria should be in accordance with the guidance contained in paragraphs 51 and 62 of AMCP 715-3 and should also be sufficient to evaluate the Contractor's HFE Plan (submitted originally as part of the contractor's proposal in HFE Block 15). (These criteria are also stated in the RFP in relative order of importance.)

c. Technique for Evaluating and Scoring Proposals: A technique for evaluating and scoring contractor proposals will be devised and evaluation forms to be used by the SSEB will be designed. The technique devised should (1) be in accordance with the general guidance contained in Chapter 9 of AMCP 715-3, (2) be reasonably congruent with the techniques being developed by other disciplines, (3) identify those HFE factors whose absence will contribute to system failure or inefficiency and weigh them accordingly, and (4) account for the cumulative effect on system efficiency of noncritical HFE factors. (Where there are major qualitative differences between the Phase B and developmental proposal evaluation criteria, it may be expedient to develop a separate technique for each meeting of the SSEB.)

When the team has received the output of HFE Blocks 14a through d, the final package of information and requirements to be presented to the Project Manager is assembled. All of the material recommended to the Project Manager by the HFE Support Team for inclusion in the RFP should meet the criteria stated in paragraph 58d, AMCP 715-3. The format for the HFE input to the RFP will be in accordance with Appendix D of AR 705-5 unless otherwise directed by the Project Manager.

Where the RFP is lengthy or the envisioned system particularly complicated, the Project Manager often finds it useful to schedule a bidders' conference prior to the presentation of proposals by the contractors. The conference permits clarification for the contractors of the technical or administrative questions arising from or related

to the RFP. Persons familiar with the background of the HFE portions of the RFP should attend such conferences.

The HFE Program Plan--originally prepared in HFE Block 11--is now updated to reflect all of the work described in this block.

BLOCK 14a - SYSTEM DESIGN INFORMATION AND REQUIREMENTS

HFE Responsibility

Determined in HFE Block 14

Output

RFP information and requirements

Portion of Selection Plan

Summary

Review System Development Plan

Consider HFE Exploratory and Advanced Development

Determine work requirements

Develop criteria for proposal evaluation

Prepare information and requirements package for RFP

Prepare portion of HFE section of Selection Plan

Designated members of the HFE Support Team review the SDP Reliability Plan, Maintainability Plan, System and Sub-System Characteristics Plan, Configuration Management Plan, Facilities Plan, Integrated Logistics Support Plan and Contract Definition Plan to insure that they understand the previous derivation and projected development of both the system itself and of the supporting HFE efforts. The work of Exploratory and Advanced Development is studied to determine the existence of requirements which should be included in the RFP as HFE system specifications (either performance or design). HFE design specifications for training equipment or facilities should also be determined (see HFE Block 14c). All other relevant information of which the contractor should be aware in preparing his proposal should be included--directly or by reference--in the RFP.

Contractor work requirements--in addition to trade-off studies--during Phase B should be determined and the appropriate work statements prepared. The delineation of the HFE parameters within which the contractor may make his Phase B trade-offs is an important--though often difficult--task. In general, the task cannot be successfully accomplished (and the Army's needs clearly stated in the RFP) unless the Mission and Performance Envelopes from CDC have been sufficiently specific for the Project Manager's engineering staff to have formulated precise design and performance specifications. It is only after studying and understanding these specifications that the latitude for HFE trade-offs can be determined and communicated in the RFP.

Contractor work requirements during development which can be foreseen at this time should be estimated and summarized in the data package of the RFP. A useful reference in preparing this summary is the sequence of blocks shown on the "System Design line" of the HFE Program Model for the Development and Production Phase.

Also in the data package should be statements specifying what HFE data is to be developed by the contractor and delivered to the Army, at what time, and--if appropriate--how. It is also usual to require that all HFE data and supporting documents (as described in paragraph 3.4, MIL-H-46855) produced by the contractor(s) be systematically maintained and be available for inspection by authorized government representatives throughout the duration of the contract.

Criteria are now prepared for proposal evaluation and a technique developed for use by the SSEB in weighing and rating the contractor proposals against the criteria. The criteria developed in this block should be such that comparisons of contractor proposals with them will disclose (1) any design features which would or might decrease either the reliability or efficiency of the required human performance and (2) the extent to which the contractor's design proposals are congruent with the function and task allocations on which they appear to be based. (For example, if two sequential human performance tasks are allocated to an equipment operator, can the operator in fact perform those two tasks in the specified sequence on the equipment which the contractor proposes to build? If so, will the required human performance be within the performance limits of the system specification and will it in any way interfere with the performance of other tasks assigned to the same operator or with the performance of other operators?) In cases where it can be anticipated that SSEB members may have difficulty in applying such criteria, the contractor

should be required to show proof in his CD report (LCMM Block 75) of operational analyses which confirm the congruence of his design proposals with his function and task allocations.

BLOCK 14b - PERSONNEL INFORMATION AND REQUIREMENTS

HFE Responsibility

Determined in HFE Block 14

Output

RFP information and requirements

Portion of Selection Plan

Summary

Review SDP Personnel Support Plan

Consider HFE Exploratory and Advanced Development

Determine work requirements

Develop criteria for proposal evaluation

Prepare information and requirements package for RFP

Prepare portion of HFE section of Selection Plan

Designated members of the HFE Support Team first orient themselves by reviewing the SDP Personnel Support Plan. If the numbers and/or types of personnel for operations, maintenance and support of the proposed system have already been established, the appropriate system specifications for the RFP will be prepared. If--as is more often the case at this point--numbers and types of personnel ultimately required will be partly determined by contractor design, constraints (if any) on the numbers (e.g., operator, 3-man team) or types (e.g., MOS 11B10, minimum GT score of 80) of personnel will be stated as system specifications, and any other information from Exploratory and Advanced Development which is pertinent to trade-off studies will be included in the data package.

If the contractor is to perform personnel work in addition to trade-off studies during Contract Definition, the details of that work will be

expressed in work statements for the Phase B contract. An estimate of the personnel work required by the contractor during development will also be prepared and included in the data package.

Special attention should be given to the development of sets of criteria for proposal evaluation--especially the set for the development contract. Criteria such as "the fewest people with the least skills" are often the first victims in trade-off studies. Consequently, the evaluation criteria (and the technique for evaluating and scoring contractor proposals) should probe the extent to which the contractor appears to have examined the personnel implications (such as numbers, duties and responsibilities of personnel, and skills and ability levels required) of his design concepts.

System specifications, work statements, evaluation criteria and technique, and the informational data package are then presented to the full HFE Support Team for final coordination before release to the Project Manager for inclusion in the RFP.

BLOCK 14c - TRAINING INFORMATION AND REQUIREMENTS

HFE Responsibility

Determined in HFE Block 14

Output

RFP information and requirements

Portion of Selection Plan

Summary

Review SDP Personnel Support Plan and Five-Year New Equipment Training Program

Consider HFE Exploratory and Advanced Development

Determine work requirements

Develop criteria for proposal evaluation

Prepare information and requirements package for RFP

Prepare portion of HFE section of Selection Plan

Designated members of the HFE Support Team first orient themselves by reviewing the SDP Personnel Support Plan and the pertinent portion of the Five-Year New Equipment Training Program. The training work accomplished during Exploratory and Advanced Development is then screened to determine relevant sections (such as training equipment requirements) which should be included in the data package of the RFP.

If the contractor is to perform training work independent of his trade-off studies during Contract Definition, the details of that work will be expressed in work statements for the Phase B contract. An estimate of the training work required by the contractor during development will also be prepared and included in the data package.

Normally this estimate will include requirements that the contractor (1) examine the verified task groups (HFE Block 15a) and the estimate

of personnel requirements (HFE Block 15b) to determine what needs to be taught to whom, (2) examine each man-machine interface to determine the presence of and correct any factors which would inhibit either training or the required performance of trained personnel, and (3) propose all of the devices and facilities which he believes are necessary for the conduct of the required training. Depending upon the anticipated complexity of the system, the government may also require that the contractor compare his requirements to available Army training resources and propose an efficient utilization of them.

In an RFP for any system large enough to undergo Contract Definition it is normal to include certain training level restrictions. They may be made in the form of either a system specification (e.g., "Facility requirements for operations and maintenance training shall not exceed those available at Fort _____") or an informational paragraph delineating the limits for trade-off studies. If field introduction of the proposed system by a certain date is important (as is often the case when an antecedent system is being phased out), the RFP should include a requirement that whatever training is necessary be accomplished by a specific target date. If no special restrictions exist (such as confining training to one geographical location location for security reasons), it may be more expedient to specify a dollar limitation on training costs. When establishing the limits of trade-offs it may also be advisable to point out for the contractor that there may be training implications in the system performance specifications developed in HFE Block 14a.

The criteria and technique for proposal evaluation developed in this block should not only weigh the facilities and device requirements, methods, complexity and estimate time for training, but should also credit attempts at solutions to HFE problems via training. Specific criteria--based on previous experience when possible--should also be developed to assist the SSEB in determining whether the proposal represents a realistic estimate of the training situation.

System specifications, work statements, evaluation criteria and technique, and the informational data package are then presented to the full HFE Support Team for final coordination before release to the Project Manager for inclusion in the RFP.

BLOCK 14d - TESTING INFORMATION AND REQUIREMENTS

HFE Responsibility

Determined in HFE Block 14

Output

RFP information and requirements

Summary

Review SDP Coordinated Test Plan

Identify projected HFE testing

Determine work requirements for Phase B

Consider HFE Exploratory and Advanced Development

Prepare information and requirements package for RFP

Designated members of the HFE Support Team review the scope of HFE testing proposed in the SDP Coordinated Test Plan. Through coordination with participating HFE agencies, a scheme of projected HFE testing is devised. This scheme, which is included in the technical data package of the RFP, should make clear to the potential contractors what HFE tests will be conducted at what points in the development process, where, by what methods and to what standards. If contractor work is required to develop test methods or standards, the appropriate work statements will be prepared for inclusion in the Phase B contract.

The team members then review the reports of HFE Exploratory and Advanced Development and place in the data package any relevant information of which the contractor should be aware. The work statements (if any) and informational data package are then presented to the full HFE Support Team for final coordination before release to the Project Manager for inclusion in the RFP.

BLOCK 15 - PREPARE HFE PORTIONS OF CONTRACTOR PROPOSAL

HFE Responsibility

Contractor

Output

HFE portions of proposal

Summary

Study HFE sections of RFP

Verify concepts stated therein or

Propose new concepts

Prepare HFE sections of proposals

NOTE

Two general alternatives are open to the contractor planning a response to the RFP: (1) assign the HFE work discussed below to project engineers as additional duty or (2) assign the work to HFE specialists. Experience seems to indicate that contractors prefer the first alternative--especially when their staff engineers are competent in the field of human factors engineering--and that, strictly on management evaluation grounds, the Army is more likely to prefer an arrangement along the lines of the second alternative. Actually neither is preëminently correct: the mere presence of "HFE specialists" on a contractor's staff is no guarantee that their entire energies will be devoted to this project or even that they will identify problems or produce results beyond the capability of the contractor's regular engineering staff. Consequently, the descriptions of the contractor blocks shown in this model will emphasize what work needs to be done (often in terms of realization of objectives) and leave the how to the ingenuity of of the contractors.

In the preparation of his proposal for the development contract, the contractor must first verify the HFE technical information contained in the RFP. Of particular importance is the function and task allocation analysis (see HFE Block 15a). During the development of gross design approaches attention should be given to each man-machine interface and its human performance requirements. These requirements in turn generate requirements for personnel selection on the basis of particular skills and abilities which, in turn, largely dictate training requirements. HFE evaluation of contractor proposals is therefore concerned with all three areas--as should be apparent from the proposal evaluation criteria listed in the RFP.

In general, the format of the HFE portion of a contractor's proposal should be two-fold: specific details pertinent to one facet of work should be included in the technical portion of the proposal where that work is described; the Contractor's HFE Plan should reference the location (in the technical portion of the proposal) of each detailed description of such HFE work and should include a narrative summary of all contemplated HFE efforts (in addition to that information discussed in HFE Block 14).

In those cases where a contractor believes a portion of the RFP to be in error or that there is technical or economic justification for suggesting new concepts in his development proposal, the HFE implications (if any) of the suggestions should be explored. In addition, if the contractor feels that the work statements offered for Phase B are inadequate, he should propose others.

BLOCK 15a - MAN-MACHINE SYSTEM CONCEPTS

HFE Responsibility

Designated by contractor

Output

Human engineering portion of proposal

Summary

Study technical sections of RFP

Conduct function and task allocation analysis

Identify high-risk areas (if any)

Apply engineering and technology resources

Assist in developing gross design approaches

Personnel designated by the contractor study the technical sections of the RFP to familiarize themselves with the system concept and its objectives. Inasmuch as the function and task allocation studies (HFE Blocks 4a and 8a) form the basis for the HFE section of the RFP, it is important that the contractor first verify the Army's function and task allocations. If, through improvements in technology, the contractor believes he can improve the system described in the RFP, it is imperative that all changes he proposes be reflected in the function and task allocations. The allocations may be documented by any of the standard techniques, although functional-flow block diagrams are most commonly used. The human performance tasks will then be grouped by performer (e.g., "driver's tasks") and an initial analysis made to verify that each group of tasks can, in fact, be performed by one person. When the results of this analysis confirm that one person can perform the entire group of tasks assigned him, the identification of his position (e.g., "driver") is said to be supported by a verified task group (see also para 3.2.1.3.2 and 30.3.7, MIL-H-46855). (Note: It will be a continual contractual requirement for the contractor

to verify the task group of each personnel position he proposes and to deliver to the Army the data which support each verification.)

When the contractor has verified the function and task allocation provided by the Army (or is satisfied with an alternative proposal), he provides the allocation documents to the personnel who will perform the work described in HFE Blocks 15b and 15c.

HFE attention must also be given to the early identification of high-risk areas--both of system performance (including reliability and maintainability) and of the comfort and safety of the system operators.

As the gross design approaches are developed, the appropriate HFE information (personnel skills, training implications, behavioral reactions, human performance, anthropometric data, and biomedical factors) must be considered. Although the contractor should expect that the relevant information will be included in the technical data package of the RFP, this expectation should not preclude the full application of the contractor's engineering and technology resources within the HFE area.

BLOCK 15b - PERSONNEL REQUIREMENTS

HFE Responsibility

Designated by contractor

Output

Personnel requirements portion of proposal

Summary

Review technical sections of RFP

Study verified function and task allocations

Determine likely personnel requirements for contractor proposal

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Personnel designated by the contractor review the technical sections of the RFP to familiarize themselves with the system concept and its objectives. The function and task allocations (to include the verified task groups) produced in HFE Block 15a are studied to determine for each personnel position identified the gross aptitude and skill levels which will be required.

If possible at this time (and depending upon the requirements for personnel work in Phase B), the contractor should also estimate the grade and MOS for each personnel position required for the operation and maintenance of the system hardware he is proposing.

The estimate of personnel requirements and supporting documentation and data should be provided to the personnel performing the work in HFE Block 15c.

BLOCK 15c - TRAINING REQUIREMENTS

HFE Responsibility

Designated by contractor

Output

Training requirements portion of proposal

Summary

Review technical sections of RFP

Study verified function and task allocations

Examine estimate of personnel requirements

Determine likely training requirements for contractor proposal

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Personnel designated by the contractor review the technical sections of the RFP to familiarize themselves with the system concept and its objectives. The function and task allocations (to include the verified task groups) produced in HFE Block 15a are studied to determine what human performance tasks must be learned and to what level. An examination of the estimate of personnel requirements produced in HFE Block 15b will indicate the individual skills and backgrounds on which the training should be based and the numbers of individuals who will need to be trained.

An estimate of training requirements should then be prepared which will describe the facilities and device requirements, methods, complexity and time anticipated for the training to support the system proposed by the contractor.

BLOCK 15d - TESTING REQUIREMENTS

HFE Responsibility

Designated by contractor

Output

Testing requirements portion of proposal

Summary

Study technical sections of RFP

Verify congruence of RFP testing plan with contractor proposal or

Propose changes to HFE testing

Personnel designated by the contractor study the technical sections of the RFP to determine what HFE testing and evaluation is planned during system development and how it relates to other testing efforts. As the contractor's proposal is developed, the personnel performing this work insure that the testing proposed in the RFP can be accomplished as stated. If, because of technological innovations, the contractor's proposal would be incompatible with the testing plans in the RFP, an alternate HFE testing scheme will be proposed. It will have the same general objectives as the original and will specify at what points in the development process, where, by what methods and to what standards the HFE testing can be accomplished.

BLOCK 16 - PROVIDE ASSISTANCE TO SSEB AS REQUIRED

HFE Responsibility

HFE Support Team

Output

Information as required

Summary

Provide HFE information and assistance as required

After the Source Selection Evaluation Board has been constituted, the Project Manager may request assistance from the HFE Support Team in briefing the Board members, explaining the HFE evaluation technique and its rationale, or answering technical questions.

BLOCK 17 - REVISE HFE PORTIONS OF CONTRACT DOCUMENTS

HFE Responsibility

HFE Support Team

Output

Revisions of Phase B contract provisions

Information and assistance as required

Summary

Review contractor proposals

Study SSEB report

Revise contract requirements for Phase B

Assist in preparing Evaluation Plan

Advise Project Manager during negotiations as required

The HFE Support Team begins the work in this block by reviewing the contractor proposals submitted in response to the RFP. The SSEB evaluations of these proposals are studied to determine what redirection and revision (if any) are required for the Phase B contracts. Revisions are made as appropriate to the Work Statements and the procedures are delineated for contract monitoring (to include requirements for interim reports by contractors).

The HFE Support Team also assists the Project Manager as requested in the preparation of portions of the Evaluation Plan (see AR 715-16). During actual negotiations with contractors the HFE Support Team may be requested to furnish technical information or advice to the Project Manager.

It is at this time, too, that the need for negotiation often arises concerning aspects of the Contractor's HFE Plan. It is necessary for both the contractor and the government to be in agreement on all of the items in that plan before the contract is executed. Conferences between members of the contractor's staff and the HFE Support Team may be required to effect this agreement before actual negotiations begin.

BLOCK 18 - MONITOR HFE PORTIONS OF CD CONTRACTS

HFE Responsibility

HFE Support Team

Output

Guidance to contractors and information to the Project Manager

Summary

Establish communications channels with Phase B contractors

Provide guidance, clarification and information to contractors as appropriate

Perform necessary in-house support work

Assist Project Manager in preparation of Contractor Performance Evaluation Reports

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The primary purpose of the work in this block is to provide adequate direction in HFE efforts to the contractors performing Phase B work. Even when the RFP work statements are precise and the ultimate goals clear, it is possible for a conscientious contractor to over-respond by performing work more appropriate to development or to place exaggerated emphasis on peripheral matters. Such inappropriate work can be costly to the government as well as confusing and misleading to the contractor. On the other hand, guidance which is too restrictive in nature defeats the purpose of Contract Definition by preventing the contractor from utilizing his total resources in attempting to resolve technical problems. The generally accepted method of contract monitoring within the Department of Defense is that of providing "negative guidance" to contractors; that is, informing a contractor when his approach is technically incorrect or unsound, when it is not clear to the government, or when it requires amplification. Inasmuch as

expression of government interest in a particular area may motivate a contractor into concentrating his effort there, care must be taken by contract monitors to insure that contractors are not led away from dealing with the primary problems of the system. In addition, the monitors should strive to provide equal help to all contractors while doing their utmost to safeguard that information and those concepts produced by each contractor which have competitive value.

Designated members of the HFE Support Team establish communications with Phase B contractors in accordance with instructions from the Project Manager and the provisions of the Phase B contracts and the Evaluation Plan (see AR 715-16), all of which serve to formalize the channels of communication between the contractors and representatives of the various government agencies concerned. HFE Support Team members monitor (by visits to the contractor facilities and by studying the reports required by the contract) the direction and progress of the contractors' efforts and provide guidance and information where appropriate. (Occasionally, in order to determine what guidance or information to provide, it may be necessary for some supporting work to be performed by one or more of the Army agencies represented on the HFE Support Team. Where the results of such work will likely be applicable only to this project, the Project Manager should be asked to provide the funds required. Where the results may affect other projects, the work may often be accomplished with RDT&E funds in conjunction with other related work in HFE Block 1.)

The HFE Support Team will also assist the Project Manager in the preparation of Contractor Performance Evaluation Reports.

BLOCK 19 - CONDUCT HFE PORTIONS OF CONTRACTOR TRADE-OFF STUDIES

HFE Responsibility

Contractor

Output

HFE trade-off recommendations

Summary

Review background documents

Identify trade-offs to be made

Determine HFE implications of each alternative

Apply technology as appropriate

Prepare HFE recommendations

A major goal of Contract Definition is the derivation of that equipment configuration for a system concept which represents the best possible balance among total cost, schedule and operational effectiveness. The derivation of the configuration is accomplished largely by trade-off studies. In performing the work in this block the contractor discharges two major responsibilities--conduct of the HFE trade-off studies specified in the Phase B contract and insurance that in other trade-off studies HFE implications are considered.

Background documents (including the RFP, Phase B contract, and backup material for the original proposal) should be reviewed to establish firmly the parameters within which the intra-system trade-offs are to be made. While the work statements of the Phase B contract will identify in general terms the required trade-offs, the contractor may discover that within each major set of viable alternatives there are several minor sets. In general, whenever two or more approaches appear to be satisfactory, the contractor should consider a trade-off (whether a formal study or informal weighing of known data is generally left to the contractor's discretion).

Often each alternative in a set being considered will have some HFE implications for operation or maintenance. It is the contractor's responsibility to determine those implications and to weigh them appropriately during the trade-off. What may initially appear to be an insurmountable HFE problem can often be overcome by design, personnel selection, or training. Consequently, by applying technological resources to HFE problems, a contractor can avoid being forced into accepting an otherwise unattractive alternative solely because is is free of HFE problems.

HFE recommendations should be prepared for each trade-off made by the contractor and documented in accordance with the provisions of the Phase B contract. If a contractor decides to adopt an alternative other than the one recommended by his HFE personnel, the HFE implications of that decision (to include a description of the extra efforts--if any--which will be required to compensate) will be recorded.

BLOCK 19a - CONSIDER HUMAN PERFORMANCE AND EQUIPMENT DESIGN

HFE Responsibility

Designated by contractor

Output

Verified task groups

Reports of operational analyses

Modifications or changes in design concepts

Summary

Review background documents

Identify trade-offs to be made

Determine HFE implications of each alternative

Explore design solutions to HFE problems

Verify compatibility of design and task allocation

Personnel designated by the contractor review background documents to identify the major trade-offs to be made and the limits of freedom for each. Additional trade-off possibilities uncovered during this work will be studied at the discretion of the contractor. HFE implications (to include effects on safety, reliability and maintainability) of each design approach considered will be determined and evaluated. Attempts will be made where possible to resolve HFE problems by design techniques.

Of prime importance in the work in this block is the constant verification of the validity of the task allocation (revised in HFE Block 15a). Where the process of contractor trade-offs tends toward many small studies rather than a few large ones, minor changes are constantly being made in the task allocations (and, therefore, in the task groups

defining personnel positions). It is therefore necessary to insure on an iterative basis that the equipment design concepts being developed remain compatible with current task allocations. The achievement of this insurance occasionally requires the conduct of limited experiments or tests. (For example, if "system reaction time" is a system performance specification, the effect of proposed equipment configurations on the speed of the required human performance may need to be established.)

The scope of this block also includes operational analyses of configuration end items (CEI's) produced by subcontractors to certain technical specifications. For instance, a verified task group may envision a crew member performing three sequential tasks on three separate CEI's--each produced by a separate subcontractor. While each CEI may meet all of the specified technical characteristics--and by itself be a reliable, well-made piece of equipment--it is also entirely possible that because of incompatibility between design and operational requirements one man may be unable to perform the three sequential tasks. The number and extent of the operational analyses of CEI's are often left to the discretion of the contractor--especially under a contract which provides incentives for the absence of HFE problems and penalties for their presence.

BLOCK 19b - DETERMINE PERSONNEL REQUIREMENTS

HFE Responsibility

Designated by contractor

Output

Description of personnel requirements for system proposal

Summary

Review background documents

Study function and task allocations

Participate in trade-off studies

Determine personnel requirements for system proposal

Personnel designated by the contractor review background documents to familiarize themselves with the nature and scope of work required and the limits within which contractor trade-offs may be made. The function and task allocations are studied continuously throughout the period of trade-offs to determine what levels of human skills and abilities will be required to perform the operation and maintenance tasks on the equipment configurations being proposed. The level of detail should be sufficient to determine the number, grade and MOS of each personnel position proposed. During trade-off studies the implications of design proposals on personnel requirements will be determined and the contractor informed if it appears that either the limits of freedom for the trade-offs or the proposal evaluation criteria are being exceeded or overlooked. The contractor should also be made aware of any portions of his personnel proposal which require personnel or skills not now available within the Army's manpower resources. When the trade-off studies are complete, a description of the personnel requirements for the contractor's proposed system should be prepared.

BLOCK 19c - DETERMINE TRAINING REQUIREMENTS

HFE Responsibility

Designated by contractor

Output

Description of training requirements for system proposal

Summary

Review background documents

Study function and task allocations and personnel requirements

Participate in trade-off studies

Determine training requirements for system proposal

Personnel designated by the contractor review background documents to familiarize themselves with the nature and scope of work required and the limits within which contractor trade-offs may be made. The function and task allocations and the description of personnel requirements are studied continuously throughout the period of trade-offs to determine in general what training methods, equipment and facilities would be required to teach the relevant operations and maintenance skills to the personnel selected. If it appears that the choice of a particular alternative in a trade-off study would cause an unwarranted training burden, exceed the stated limits of freedom for the trade-off, or flout training criteria for proposal evaluation, the contractor should be informed.

The engineering concepts proposed and the operational analyses performed on CEI's (in HFE Block 19a will be studied to determine those areas where human malperformance may be critical (i.e., result in significant degradation of effectiveness or in complete system failure). While it is often easier to spot these areas among the operations tasks, careful attention should be also given to proposed maintenance tasks. Where human malperformance can be identified as critical, special or extra training to minimize the likelihood of the malperformance should be proposed and its worth assessed.

When the trade-off studies are complete, a description of the training requirements for the contractor's proposed system should be prepared. The contractor may be required to include in this description a comparison of his requirements with the present or anticipated training resources of the Army and an estimate of the dollar cost to the Army to conduct and support the training he proposes.

BLOCK 19d - TESTING REQUIREMENTS

HFE Responsibility

Designated by contractor

Output

Description of testing proposed for system

Summary

Review technical section of RFP

Monitor trade-off studies

Propose changes in HFE testing as appropriate

Personnel designated by the contractor review the technical section of the RFP to familiarize themselves with the government's original HFE testing scheme. Counter-proposals which may have been made in HFE Block 15 are also examined. Throughout the period of trade-off studies, the personnel performing the work of this block assess the implications on testing of major alternatives being considered by the contractor. It is not the intention of this block to have testing requirements be a factor in making trade-offs; a change in the government's testing scheme should not be cause for abandoning an otherwise acceptable alternative. However, it is important that, if testing changes are necessary, they be identified promptly. Where the contractor deviates from the government's testing scheme, he should propose a reasonable alternative plan which fits his proposal while meeting the same objectives.

BLOCK 20 - EVALUATE HFE ASPECTS OF CONTRACTOR TRADE-OFFS

HFE Responsibility

HFE Support Team

Output

HFE recommendations for trade-off decisions

Summary

Review Mission and Performance Envelopes

Examine contractors' trade-off studies

Identify problem areas and propose solutions

Prepare HFE recommendations for Project Manager

The HFE Support Team members prepare themselves for the work in this block by reviewing CDC's Mission and Performance Envelopes (LCMM Block 23) and QMR (LCMM Block 42). These two documents should be sufficient to explain clearly what it is that the user wants for what purpose and under what circumstances and in what environments it will be used. The Team then examines the HFE-related portions of the contractors' trade-off studies. If the contractor has performed his work properly, the report will include an assessment of the HFE implications of each trade-off being proposed. The HFE Support Team should insure that the assessment is correct and complete and that no combination of trade-offs being proposed will produce an HFE problem not yet identified.

In those cases where the assessment of HFE implications of a proposed trade-off is incorrect or incomplete, the HFE Support Team may recommend to the Project Manager that additional studies or research be conducted before any decisions are made to approve trade-offs. Such a recommendation is particularly important when it appears that adoption of a particular trade-off might degrade required human performance below the level required to sustain system operation.

If, in the judgment of the HFE Support Team, an HFE contention advanced by a contractor is doubtful--even though it may appear to be supported by data--the Team should recommend to the Project Manager that the contractor be required to demonstrate the validity of his contention.

The analysis and evaluation of contractor trade-off studies may uncover problem areas of varying degrees of seriousness. The HFE Support Team should provide technical guidance to the Project Manager concerning the most expedient method for overcoming the problems. In general, critical problems should be dealt with during Phase B of Contract Definition--either by additional contract studies or by research in government laboratories. Minor problems may often be handled by adding additional work statements to the development contract (see HFE Block 25).

Following the analyses of contractor trade-off proposals in HFE Blocks 20a, b, c and d, a coordinated set of HFE recommendations is prepared for the Project Manager. Unless directed otherwise by the Project Manager, the recommendations will cover all trade-offs proposed and will include a finding of each as one of the following:

a. Acceptable as stated--no significant HFE problems would be incurred by adoption of this proposal.

b. Acceptable with restrictions--certain HFE disadvantages are associated with this proposal and/or additional effort and funds will be required to achieve satisfactory resolution of problems.

c. Unacceptable--insurmountable HFE problems are associated with this proposal. (When a proposed trade-off is found to be unacceptable from an HFE point of view, acceptable alternative approaches should be identified.)

BLOCK 20a - EVALUATE HUMAN PERFORMANCE AND EQUIPMENT DESIGN

HFE Responsibility

Determined in HFE Block 20

Output

Preliminary recommendations--human engineering

Summary

Examine contractors' trade-off studies

Assess compatibility of equipment design concepts and required human performance

Identify problem areas and propose solutions

Prepare recommendations

Designated members of the HFE Support Team examine the contractors' trade-off studies first to determine whether the proposals violate the limits for trade-offs (set in HFE Block 14a) and, if so, whether the violation can be tolerated. Next, the verified task groups (which describe the human performance requirements of each personnel position identified in the contractors' proposals) are studied in detail. Of particular concern to the HFE Support Team members should be inquiries to determine the compatibility of each verified task group with the equipment on which those tasks would be performed. Where compatibility is not clear on any particular man-machine interface, data from operational analyses of the CEI's involved should be examined. Also, the degree to which the contractors have considered the influences on human performance (and, therefore, on total system reliability) of the likely physical environment and personnel interactions should be assessed.

In any case where the function and task allocation or verified task group is found to be incorrect or incomplete, notice of the discovery of the error will be promptly provided to the personnel accomplishing the work described in HFE Blocks 20b c. and d. The effect of the error on the total trade-off proposal should be fully ascertained and explained clearly in the HFE recommendations to the Project Manager.

Problem areas identified during the evaluation of trade-off proposals should be studied and solutions--or methods to achieve solutions--recommended.

Preliminary recommendations reflecting the HFE evaluation of the human engineering implications of contractor trade-offs should be drafted and presented to the full HFE Support Team for final coordination before release to the Project Manager.

BLOCK 20b - EVALUATE PERSONNEL REQUIREMENTS

HFE Responsibility

Determined in HFE Block 20

Output

Preliminary recommendations--personnel

Summary

Examine contractors' trade-off studies

Insure appropriateness of proposals

Identify problem areas and propose solutions

Prepare recommendations

Designated members of the HFE Support Team examine the contractors' reports of trade-off studies to determine whether the personnel requirements proposed have violated the limits (set in HFE Block 14b) for the trade-offs and, if so, whether the violation can be tolerated. The supporting data in the studies are reviewed to insure that the personnel position descriptions proposed by the contractor(s) follow logically from the function and task allocations and that they are in consonnance with present DA policy in the assignment of grade and MOS. Required aptitude and skill clusters not presently available or identifiable within Army manpower resources are identified and the steps necessary to acquire them are outlined.

Problem areas identified during the evaluation of trade-off proposals should be studied and solutions--or methods to achieve solutions--recommended.

Preliminary recommendations reflecting the HFE evaluation of the personnel implications of contractor trade-offs should be drafted and presented to the full HFE Support Team for final coordination before release to the Project Manager.

BLOCK 20c - EVALUATE TRAINING REQUIREMENTS

HFE Responsibility

Determined in HFE Block 20

Output

Preliminary recommendations--training

Summary

Examine contractors' trade-off studies

Determine adequacy and validity of training proposals

Identify problem areas and propose solutions

Prepare recommendations

Designated members of the HFE Support Team examine the contractors' trade-off studies to determine the adequacy and validity of the training proposals. The determination of adequacy should include, but not necessarily be limited to, considerations of whether (1) the proposal violates the limits for trade-offs (set in HFE Block 14c) and, if so, whether the violation can be tolerated; (2) the cost of the proposed training has reasonably and correctly been estimated; and (3) the time required for the conduct of the proposed training will not compromise the target date for introduction of the system in the field. Once adequacy has been determined, an examination into the validity of the proposals is begun. The HFE Support Team members performing the work in this block should first examine the assumptions on which the training proposals are based and then verify the methods proposed for the transfer of information and its subsequent retention and recall by personnel. The need for special devices to facilitate skill development should be determined to include an assessment of the probable degree to which the devices proposed by the contractor will fill the need. The probable effectiveness of training proposed to minimize the likelihood of critical human malperformance should be assessed.

Problem areas identified during the evaluation of trade-off proposals should be studied and solutions--or methods to achieve solutions--recommended.

Preliminary recommendations reflecting the HFE evaluation of the training implications of contractor trade-offs should be drafted and presented to the full HFE Support Team for final coordination before release to the Project Manager.

BLOCK 20d -- EVALUATE TESTING REQUIREMENTS

HFE Responsibility

Determined in HFE Block 20

Output

Preliminary recommendations--testing

Summary

Examine contractors' trade-off studies

Identify required changes in CTP and development contract if trade-offs are adopted

Determine adequacy of contractors' testing proposals

Formulate changes in HFE testing to support trade-offs

Coordinate proposed changes as appropriate

Designated members of the HFE Support Team examine the contractors' trade-off studies to identify those changes (if any) which would be required in the CTP and in the provisions of the development contract if the trade-offs are adopted. In those instances where a proposed trade-off would occasion a change in the HFE testing scheme originally proposed (HFE Block 14d), the contractor should have proposed an alternative plan. The adequacy of this plan and its ability to meet the objectives of the HFTE program should then be determined.

Such changes to the original HFE testing scheme as would be required by the adoption of any of the proposed trade-offs are formulated at this time. Each of the HFE agencies which concurred in the original testing scheme should have the opportunity to review and comment upon the proposed changes.

BLOCK 21 - UPDATE SYSTEM DEVELOPMENT PLAN

HFE Responsibility

HFE Support Team

Output

Revisions of HFE portions of System Development Plan

HFE input to system and development descriptions

Revision of HFE Program Plan

Summary

Review trade-off decisions

Determine appropriate HFE efforts

Expand and update HFE input to SDP

Prepare HFE input to system and development descriptions

After decisions have been made by the government on the trade-offs of characteristics proposed by the contractor, the HFE implications of the decisions are determined and appropriate revisions made in the input to the various SDP subplans. In addition, the generalities and objectives which were written into the original PSDP (in HFE Block 11) are now expanded to include specifics and detailed methods of accomplishment. To achieve the objective of total integration of manpower resources, it is imperative that the HFE considerations implanted in the SDP subplans have themselves been thoroughly coordinated among all HFE agencies participating in the project before being released to those agencies preparing the subplans.

Some of the same information and requirements now being developed for the HFE portions of the various SDP subplans should also be included in the system and/or development descriptions (see AMCR 11-26). Such material should be identified and, following coordination

before the full HFE Support Team, should be provided directly to the Project Manager.

Careful attention to detail in performing the work in this block will greatly simplify the efforts described in HFE Blocks 23 and 25.

The HFE Program Plan is now updated to reflect all of the work in this block.

BLOCK 21a - SYSTEM DESIGN AND DEVELOPMENT SUPPORT

HFE Responsibility

Determined in HFE Block 21

Output

HFE input for SDP

- Reliability Plan
- Maintainability Plan
- System and Sub-System Characteristics Plan
- Configuration Management Plan
- Facilities Plan
- Integrated Logistics Support Plan
- Contract Definition Plan

Summary

Review trade-off decisions and supporting documentation

Expand HFE system specifications

Draft HFE inputs to SDP subplans

Coordinate drafts among HFE agencies

Submit drafts to agencies preparing subplans

Designated members of the HFE Support Team review the trade-off decisions made by the government and the supporting engineering documents. The decisions and documents together provide the basis for expansion of the HFE system specifications to include preparation

of HFE portions of the system and development descriptions (see AMCR 11-26). Design considerations advanced by the trainer (explained in HFE Block 11c) are studied at this time and appropriate inputs are prepared for the relevant SDP subplans.

The list of configuration end items (CEI's) is examined to determine those which have human interfaces or require human performance during operation or maintenance. HFE basic design considerations applicable to each such CEI are determined and stated in the System and Sub-System Characteristics Plan--often by reference to a standard HFE guide. (For example, if one CEI is an information display for the equipment operator, it may suffice to require that that CEI be designed in accordance with paragraph 5.2, MIL-STD-1472.)

Improvements in maintainability or reliability and modifications to facilities or logistics requirements resulting from expanded design specifications are noted in the appropriate SDP subplans. Standards against which specifications will later be tested and the proposed methods of testing will be furnished to those HFE Team members performing the work in HFE Block 21d.

The draft inputs to SDP subplans will then be coordinated with all participating HFE agencies to insure complete integration of HFE effort and then forwarded to the agency preparing each of the subplans listed above.

BLOCK 21b - SYSTEM PERSONNEL REQUIREMENTS

HFE Responsibility

Determined in HFE Block 21

Output

HFE input for SDP Personnel Support Plan

Summary

Review trade-off decisions and supporting material

Determine personnel implications of trade-off decisions

Draft revision to Personnel Support Plan

Coordinate draft among HFE agencies

Submit draft to agency preparing Personnel Support Plan

Designated members of the HFE Support Team review the trade-off decisions made by the government and the supporting material. The personnel implications (such as number, grade and MOS of the people required for operation and maintenance--plus their necessary aptitudes and skill levels) of each decision are determined and the appropriate changes made to the HFE input to the Personnel Support Plan. If the trade-off decisions appear to have produced requirements beyond those estimated in HFE Block 8k, it may be necessary for an immediate study to determine whether the new requirements can be met within the Army personnel system and what additions (if any) to current selection procedures should be considered.

The draft input to the SDP Personnel Support Plan will then be coordinated with all participating HFE agencies to insure complete integration of HFE effort before being forwarded to the agency preparing that plan.

BLOCK 21c - TRAINING PROGRAM PLANNING

HFE Responsibility

Determined in HFE Block 21

Output

HFE input for

SDP Personnel Support Plan

Five-Year New Equipment Training Program

Summary

Review trade-off decisions and supporting documentation

Determine training implications of trade-off decisions

Draft expansion of training plans

Coordinate drafts among HFE agencies

Submit drafts to appropriate agencies

The purpose of the work in this block is to expand the plans for training which were prepared in HFE Block 11c. The amount of detail which can be put into training plans at this time will, of course, depend largely upon the degree to which the proposed system has been defined and described. In general, however, the plans produced in this block should be specific enough to permit management visibility of the proposed training activities of both the trainer and the developer during development. It is particularly important that these sets of activities be coordinated to insure that the developer's planned New Equipment Training Program will satisfy all of the needs of the trainer.

Designated members of the HFE Support Team review the trade-off decisions made by the government to determine the training implications (if any) of each. With these implications in mind, they then

expand the training plans of both trainer and developer. Any design considerations advanced by the trainer are provided to the personnel accomplishing the work in HFE Block 21a. Anticipated standards and techniques to be used in evaluating training are furnished to the personnel performing the work in HFE Block 21d. Drafts of expanded plans are then coordinated with all participating HFE agencies to insure complete integration of HFE effort and are then submitted to the appropriate agencies.

BLOCK 21d - TESTING AND EVALUATION

HFE Responsibility

Determined in HFE Block 21

Output

HFE input for SDP Coordinated Test Plan

Summary

Review trade-off decisions

Consider previously proposed test changes

Solicit complete HFTE requirements

Draft and coordinate expanded testing scheme

Submit draft to agency preparing CTP

Designated members of the HFE Support Team review the trade-off decisions made by the government to gain a closer idea of the likely man-machine interfaces which will exist in the system and the human factors test and evaluation (HFTE) efforts which will be required to achieve the objectives specified in paragraph 3 of the introduction to this document. The original HFE input for the coordinated test plan (produced in HFE Block 11d) is now expanded to include details of the anticipated HFE participation in each of the seven tests in the development cycle (see AR 70-10).

Complete test requirements (to include all necessary facilities and support) will be solicited from each of the participating HFE agencies. These requirements should reflect an understanding of the previous work and refinement of testing by both contractors and the Army during Phase B. The test requirements from all HFE agencies are combined into one plan which has as its overall goal the measurement of total system performance as a function of each man-machine interaction. Where such measurement can be achieved, it is far easier to detect

and correct the cause(s) of inadequate performance (improper design, incorrect personnel selection, or insufficient training).

The draft of the total HFE test requirements will follow the format prescribed in paragraph 14b, AR 70-10, and will be coordinated with all participating HFE agencies before being submitted to the agency preparing the CTP.

BLOCK 22 - PROVIDE ASSISTANCE TO SSEB AS REQUIRED

HFE Responsibility

HFE Support Team

Output

Information as required

Summary

Provide information to SSEB as required

Members of the HFE Support Team may be called upon by the Project Manager to provide technical assistance to the Source Selection Evaluation Board (SSEB). This assistance will normally be limited to:

a. Providing briefings on HFE-related subjects concerning development of the proposed system.

b. Providing information concerning contractor work during Phase B.

c. Answering technical questions from members of the Board.

BLOCK 23 - PARTICIPATE IN CONTRACT DEFINITION IPR

HFE Responsibility

HFE Support Team

Output

HFE briefing for IPR

Summary

Review results of previous work

Determine current status of project and problems

Propose HFE activities for Phase C

Prepare briefing for IPR

Provide HFE information and advice as required

The HFE Support Team prepares for the IPR by reviewing all of the previous work (both government and contractor) which has HFE implications. The status of the project is then determined to be either "satisfactory" or "unsatisfactory" in each of the four general areas (design, personnel, training and testing). Problems--particularly recurrent or significant ones--are noted and, where possible, either solutions proposed or courses of action recommended. A short description should also be prepared indicating what responsibilities and activities the HFE Support Team contemplates for the remainder of Phase C.

A formal briefing (with handouts if necessary) should then be prepared covering the above information. The Team should insure adequate representation at the IPR to provide on-the-spot information or advice in any of the four primary HFE areas.

BLOCK 24 - REVISE HFE REQUIREMENTS FOR THE DEVELOPMENT CONTRACT

HFE Responsibility

HFE Support Team

Output

HFE requirements for development contract

Summary

Review HFE input to RFP

Study Phase B changes to system concept

Consider results of IPR and SSE

Revise HFE requirements for development contract

The purpose of the work in this block is to insure that the progress made in the major HFE areas during contract definition carries forward into development. To insure that the contractor who wins the development contract understands precisely what is expected of him (and to what minimum standard of excellence) it is necessary to specify in the contract all of the HFE considerations which apply. It is patently unfair to the contractor to make demands for services during development which are not specified in his contract and for which he is not scheduled to be paid--even though such services may be vital to the project. Although portions of major contracts can be renegotiated if circumstances warrant, the procedure is lengthy and costly to the government and nearly always antagonizes the Project Manager. Consequently, it is important to perform the work in this block thoroughly and well.

The HFE Support Team reviews the original HFE input to the RFP (HFE Block 14) and then studies all of the technical information which has been produced thus far during contract definition. Often, especially

in the trade-off studies, this information has served to make significant alterations to the original concepts proposed by the government in the RFP. Although the HFE implications of the trade-off decisions have been previously considered (HFE Blocks 20-21, they must now be translated directly into specifications or clauses in the development contract. Two other sources which also produce changes in concepts and approaches are the general information exchange (LCMM Block 80) and the decisions from the System Status Evaluation (LCMM Block 81). The HFE Support Team must insure that it receives from the Project Manager--preferably in writing--all of the decisions which may bear on the application of HFE in subsequent development. It is then the responsibility of the Team to respond with the appropriate clauses for the development contract.

Unless directed otherwise by the Project Manager, the format for the HFE requirements should follow that of the RFP. Clauses recommended for direct insertion in the contract should be written clearly and simply so that later claims of "misunderstanding" or "misinterpretation" can be avoided.

Recommended contract requirements produced in HFE Blocks 24a, b, c, and d should be coordinated before the full HFE Support Team prior to release to the Project Manager.

BLOCK 24a - MAN-MACHINE SYSTEM REQUIREMENTS

HFE Responsibility

Determined in HFE Block 24

Output

Human engineering requirements for development contract

Summary

Review HFE input to RFP

Study changes to and expansions of design concepts

Prepare human engineering requirements for development contract

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Designated members of the HFE Support Team first review the HFE-related sections of the RFP. Then, with the original concepts and requirements in mind, they study the concept changes which have resulted from Phase B and the subsequent government decisions. These changes are then incorporated into human engineering requirements for the development contract in one or more of the following formats:

a. System design specifications. These requirements concern the construction of the equipment itself and are generally concerned with such matters as configuration (size and shape), type of material used, or other physical qualities. Those basic design considerations produced in HFE Block 21a which are still applicable and necessary for the satisfactory human engineering of the system should be translated into design specifications.

b. System performance specifications. These requirements concern measurable qualities of the operation or emission of the equipment (such as sound pitch and duration, time or speed of operation, or temperature) or of some human performance connected with it

(such as magnitude of human effort required for operation, maximum time allowable for operator disassembly, or minimum operating time without maintenance).

c. Work statements. These requirements generally refer to contractor services which are desired during the development or construction of equipment. Of particular importance to HFE personnel are statements requiring the contractor to perform operational analyses at specified intervals to insure compatibility of equipment configuration with thehuman performance specified in the task allocations. Also, requirements for the contractor to make regular reports to or have consultation with government HFE personnel may be necessary--especially when the design concepts proposed during Phase B may require considerable alteration. Requirements for the contractor to alter his design proposals which do not meet HFE design or performance specifications at the behest of the government or to adopt "better" government designs must also be in accordance with the provisions of the Configuration Management Plan and even then usually require the direct approval of the Project Manager.

As a general practice, each of the system specifications prepared in this block should appear in the test plan for evaluation of hardware. Each such specification (with suggested procedures for testing, where appropriate) should be provided to the personnel performing the work in HFE Block 24d.

BLOCK 24b - PERSONNEL REQUIREMENTS

HFE Responsibility

Determined in HFE Block 24

Output

Personnel requirements for development contract

Summary

Review HFE input to RFP

Study changes in utilization of personnel

Prepare personnel requirements for development contract

Designated members of the HFE Support Team review the original information and requirements provided for the RFP in HFE Block 14b and then record the conceptual changes which have occurred up to this time. Where necessary, the original requirements are eliminated, broadened or made more specific. Changes (if any) are reflected in revised system specifications or work statements.

BLOCK 24c - TRAINING REQUIREMENTS

HFE Responsibility

Determined in HFE Block 24

Output

Training requirements for development contract

Summary

Review HFE input to RFP

Study changes in training concepts

Prepare training requirements for development contract

Designated members of the HFE Support Team first review the original information and requirements provided for the RFP in HFE Block 14c. The validity of the original trade-off limits are reassessed in the light of any changes in training concepts which have occurred during contract definition. Where necessary, the original requirements are eliminated, broadened, or made more specific. Training device requirements are prepared (and, where design specifications are important, are coordinated with the personnel performing the work in HFE Block 24a). Performance specifications pertinent to training and work statements describing contractor responsibilities are formulated. Projected evaluations of training or tests of performance specifications (with suggested procedures for testing, where appropriate) should be provided to the personnel performing the work in HFE Block 24d.

BLOCK 24d - TESTING REQUIREMENTS

HFE Responsibility

Determined in HFE Block 24

Output

Testing requirements for development contract

Summary

Review HFE input for RFP

Study HFE test descriptions in CTP

Prepare testing requirements for development contract

Designated members of the HFE Support Team first review the information and requirements provided for the RFP in HFE Block 14d. Major changes in testing concepts or procedures occasioned by alterations to the original system concept should have been dealt with already (see HFE Block 21d). However, additional information may now be provided from HFE Blocks 24a and c. At this time it is necessary to translate certain portions of the CTP into contract clauses which will describe clearly and completely what responsibilities the contractor will have (to include provision of facilities, personnel and test equipment) in each of the planned HFE tests. In addition, procedures for retests in the event of failures should be specified.

BLOCK 25 - ASSIST PROJECT MANAGER IN REVISING DOCUMENTATION

HFE Responsibility

HFE Support Team

Output

HFE information for

System Development Plan

System Description

Qualitative Materiel Requirement

Summary

Review concept and requirement changes

Insure HFE portions of major documents are complete and correct

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The Project Manager is now required to submit major project documents to DA for approval and authority to proceed with engineering or operational system development. Minor revisions and updating are often required at this point, and the resources of the HFE Support Team should be made available to assist as required.

BLOCK 26 - ESTABLISH HFE SUPPORT BASE

HFE Responsibility

Designated by developing agency

Output

Management support to developer (continuing)

HFE requirements for development contract

HFE Program Plan

Summary

Establish HFE Support Team which

Provides HFE management support to developer

Participates in System Description/Coordinated Test Program IPR

Prepares HFE requirements for development contract

Maintains HFE Program Plan

NOTE

The work described in this block is applicable only when a system passes from Phase I (Concept Formulation) to Phase III (Development and Production) without passing through Phase II (Contract Definition). In this case, there is no "Project Manager" as defined in AR 70-17. Management functions remain with the developer but are usually assigned to a subordinate command. Within AMC, management authority is usually delegated to a commodity command. In the HFE blocks which follow read in that designated management command each time the term "Project Manager" is used.

Following approval by DA (in LCMM Block 43) for engineering or operational system development, the command assuming management authority designates an HFE agency responsible for the integration of manpower resources in the development of the system. This agency--ordinarily the same one assigned the responsibility in HFE Block 2--reviews, in close coordination with the developer, the anticipated scope of HFE involvement during development. As a result of this review, the HFE agency effects liaison with any Army agencies which were not represented on the HFE Concept Team and which may now be able to contribute to the project.

The HFE Concept Team now disbands and those members who will remain with the project--plus any representatives from the other HFE agencies just contacted--form the HFE Support Team. Each member of this team will insure that his parent agency is kept informed of the work of the full HFE Support Team and will also report to the team the progress of his agency's work on the project. In general, the HFE Support Team responds directly to the developing agency and has the following duties:

a. Identifying and insuring timely programming and development of HFE objectives applicable to the project.

b. Developing and maintaining required documentation and reports for management and record purposes.

c. Insuring that adequate financial support for HFE work is included in the formal planning documents.

d. Incorporating HFE requirements in contracts and work statements, as required, to obtain specified products and data on a timely basis.

e. Monitoring of required HFE work performed by contractors.

f. Collecting, coordinating and analyzing HFE information and data as it becomes available, determining the implications for the project of this data; and advising the Project Manager of pertinent developments and necessary changes.

g. Insuring by participation in IPR's and by liaison with other groups supporting the project that HFE activities and products are complementary to and compatible with other system development activities (e.g., data and configuration management, value and safety engineering, reliability and maintainability programs).

When the HFE Support Team has been established for this project, it begins work by reviewing the results of Exploratory and Advanced Development and preparing for the System Description/Coordinated Test Program IPR. An IPR briefing is prepared (with handouts if appropriate) which covers (1) proposed HFE portions of the system description and (2) anticipated HFE work in design, personnel, training and testing. The contents of this briefing should be coordinated in advance by the members of the HFE Support Team who should also attend the IPR to provide on-the-spot information or advice as required in any of the four primary HFE areas.

The HFE Support Team studies the decisions made at the IPR and subsequent SSE and then prepares HFE requirements for the development contract. The purpose of and method and format for preparing these requirements are similar to those discussed in HFE Blocks 24 and 24a, b, c and d. In addition, the contractor should be required by a separate provision of the contract to prepare, submit for government approval, and then maintain throughout the duration of the contract a Contractor's HFE Plan (see description in HFE Blocks 14 and 15).

At this time, also, the team prepares the HFE Program Plan. This plan, which will be updated periodically throughout development, is intended primarily to provide management visibility to HFE efforts. It includes a plan for all HFE work, the information and recommendations resulting from such work, and a record of the HFE considerations or requirements implanted in other documents.

BLOCK 27 - ADVISE PROJECT MANAGER AS REQUIRED

HFE Responsibility

HFE Support Team

Output

Recommendations and information as required

Summary

Provide HFE information and recommendations as required

The Project Manager may request HFE assistance during contract negotiation--particularly when the work in HFE Block 24 has resulted in major changes in contractual requirements from those originally stated in the RFP. Also, contractors may have counter-proposals to make to new HFE requirements which would require fast and accurate appraisal.

It is at this time, too, that the need for negotiation often arises concerning aspects of the Contractor's HFE Plan. It is necessary for both the contractor and the government to be in agreement on all of the items in that plan before the contract is executed. Conferences between members of the contractor's staff and the HFE Support Team may be required to effect this agreement before actual negotiations begin.

The HFE Support Team insures availability to the Project Manager of the necessary information and assistance.

SECTION III

Development and Production Phase

BLOCK 28 - PREPARE INTEGRATED HFE MANAGEMENT PLAN

HFE Responsibility

HFE Support Team

Output

HFE Input to Project Master Plans and Schedules

Summary

Establish integrated personnel staffing plan for HFE

Establish HFE Program milestones

Prepare HFE Input to Project Master Plans and Schedules

The Project Management Master Plans are a collection of individually approved documents (prepared by the Project Manager with assistance from participating organizations), that place in context plans, schedules, costs, technical parameters and the scope of work of Project Manager and supporting AMC functional elements.

Cost and schedule inputs from the HFE supporting elements will be integrated into the master schedule and cost breakdown. It is therefore incumbent upon the HFE Support Team to conduct an early coordination conference immediately after award of the development contract to develop final plans for supporting the project manager for the remainder of the RDT&E cycle.

Review of the preliminary schedule must be accomplished and plans for the integration of all HFE milestones within the master schedule formulated. Similarly a plan showing manpower allocations from the various HFE supporting elements must be developed. From this, total in-house costs are developed for submittal to the project manager for approval, and for incorporation in total government cost estimates.

In order to maintain a continuing interchange of technical information between the HFE Support Team and the contractor's HFE personnel, and to provide for adequate monitoring of the state of system design, periodic meetings (apart from formal design reviews and IPR's) should be scheduled by the HFE Support Team. The schedule of these meetings should be part of the Project Master Plans and Schedules.

It is also extremely important that the HFE Support Team maintain management and technical visibility over the contractor's HFE program so that technical and administrative problems can be resolved as early as practicable in order to avoid excessive delay or costly Engineering Change Proposals (ECP's).

BLOCK 28a - SYSTEM DESIGN REQUIREMENTS

HFE Responsibility

Determined in HFE Block 28

Output

System design requirements inputs for Project Master Plans and Schedules

Summary

Review previous system design and development efforts

Determine nature and extent of HFE efforts required

Coordinate requirements among HFE agencies

Prepare plans or summaries as required

Designated members of the HFE Support Team review previous design and development efforts on the selected system, as well as previous efforts on other development programs. Specific milestones to denote initiation and completion of HFE design and development effort during the Development and Production Phase are generated and coordinated with other members of the team. Detailed manpower allocations, on a time base, are developed to delineate the extent of support required.

BLOCK 28b - PERSONNEL REQUIREMENTS

HFE Responsibility

Determined in HFE Block 28

Output

Personnel requirements inputs for Project Master Plans and Schedules

Summary

Review previous system personnel reports

Determine nature and extent of HFE efforts required

Coordinate requirements among HFE agencies

Prepare plans or summaries as required

Designated members of the HFE Support Team review previous personnel work performed on the selected system, as well as previous efforts on other development programs. Specific milestones to denote initiation and completion of HFE personnel effort during the Development and Production Phase are generated and coordinated with other members of the team. Detailed manpower allocations, on a time base, are developed to delineate the extent of support required.

BLOCK 28c - TRAINING REQUIREMENTS

HFE Responsibility

Determined in HFE Block 28

Output

Training requirements inputs for Project Master Plans and Schedules

Summary

Review previous system training reports

Determine nature and extent of HFE efforts required

Coordinate requirements among HFE agencies

Prepare plans or summaries as required

Designated members of the HFE Support Team review previous training efforts conducted relative to the selected system, as well as previous efforts on other development programs. Specific milestones to denote initiation and completion of training effort during the Development and Production Phase are generated and coordinated with other members of the team. Detailed manpower allocations, on a time base, are developed to delineate the extent of support required.

BLOCK 28d - TEST AND EVALUATION REQUIREMENTS

HFE Responsibility

Determined in HFE Block 28

Output

Test and evaluation requirements inputs for Project Master Plans and Schedules

Summary

Review CTP and previous system test and evaluation reports

Determine nature and extent of HFE efforts required

Coordinate requirements among HFE agencies

Prepare plans or summaries as required

Designated members of the HFE Support Team review the HFE input to the Coordinated Test Plan (as updated in HFE Block 21d) and previous HFE testing and evaluation performed on the selected system, as well as previous efforts on other development programs. Specific milestones to denote initiation and completion of HFE testing and evaluation effort during the Development and Production Phase should be determined and coordinated with other members of the team. Detailed manpower allocations, on a time base, are developed to delineate the extent of support required.

BLOCK 29 - HFE PRELIMINARY DESIGN EFFORT

HFE Responsibility

Contractor

Output

HFE input to preliminary design of system and related maintenance, support, and facilities end items

Summary

Study HFE sections of development contract

Update data and studies

Conduct additional supporting studies and analyses

Personnel designated by the contractor study the technical sections of the contract to familiarize themselves with system changes and requirements which have been brought about after Contract Definition and during contract negotiation (LCMM Block 104). Specific HFE requirements in the System Description and Development Descriptions must be reviewed such that all manpower characteristics, including personnel skills, training implications, behavioral reactions, human performance, and anthropometric and biomedical factors can be effectively integrated into the design. The contractor must assure that HFE inputs are made to other system effectiveness disciplines, including reliability, maintainability, safety, and value engineering, in order that design decisions which are made reflect an integrated approach.

It is vital that contractor personnel responsible for HFE work review and approve all drawings, sketches, and equipment layouts which have a man-machine interface. Similarly, it must be assured that subcontractor work statements and contracts reflect HFE requirements stated in the Development Descriptions. HFE approval of drawings shall constitute verification that the system and subsystem configuration and arrangement satisfy the HFE requirements of the contract.

It is incumbent upon the contractor to update and maintain all applicable HFE data established during Contract Definition. These data should include, but not be limited to the following: system engineering analyses, design review results, sketches and drawings, checklists, design and test notes, function and task data, operational analyses of all CEI's, and other supporting and background documents reflecting HFE actions and decisions.

BLOCK 29a - UPDATE FUNCTION AND TASK ALLOCATION STUDIES

HFE Responsibility

Designated by contractor

Output

Report of revised function and task allocation studies

Summary

Review technical requirements of the contract

Verify compatibility of design and task allocation

Perform link analyses of critical CEI's

Perform time line analyses

Prepare inputs to HFE system design

Prepare inputs to personnel requirements and training studies

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Personnel designated by the contractor study the revisions to the System Description and Development Descriptions incorporated in the contract. Where changes have been imposed on the contractor's design subsequent to Phase B of Contract Definition, attendant changes must now be made to the basic function and task data. Task groups verified in HFE Block 19a should be reverified. It is anticipated that during this second iteration of the task studies, the data developed will become more precise as the system undergoes a more thorough design and development process.

Such a refinement of task data should result in the identification of (1) information required by man, (2) information available to man, (3) evaluation process, (4) decision reached after evaluation, (5) action taken, (6) body movements required by action taken, (7) workspace envelope for man required by action taken, (8) workspace available to man,

(9) location and condition of the work environment, (10) frequency and tolerances of action, (11) time base, (12) feedback informing man of the adequacy of his actions, (13) tools and equipment used, (14) number of personnel required, their specialty and experience, (15) job aids or references required, (16) communications required, (17) special hazards, and (18) operator interaction where more than one crew member is involved. The results of these analyses are used as the basis of more detailed time line analyses and link analyses (developed in HFE Block 33a) of CEI's requiring critical human performance.

The results of these analyses are provided to other HFE personnel who are responsible for updating personnel and training studies (HFE Blocks 29e and 29f). The analyses are also used by system design personnel (HFE Blocks 29c and 29d) as the basis for the establishment of control/display design characteristics, workplace layout, anthropometric factors, and other accepted human engineering design considerations. It is also essential that the results of the analyses be coordinated with reliability, maintainability, safety and value engineering groups. In this way human performance requirements are compared with maintenance concepts, equipment failure and down time predictions, as well as safety considerations.

In order to validate the updated task studies it may become necessary for HFE testing to be conducted (HFE Block 29g) using mockups, or preferably actual equipment, although equipment is not usually available at this stage of the development process.

Additionally, function and task allocation studies provide a basis for HFE tradeoff studies to be performed in HFE Block 29h.

BLOCK 29b - VERIFY ENVIRONMENTAL AND SAFETY FACTORS

HFE Responsibility

Designated by contractor

Output

Report of studies conducted to verify environmental and safety factors

Summary

Review technical requirement of the contract

Verify adequacy of life support and environmental criteria

Assess system safety

Personnel designated by the contractor review the alterations to the System Description and Development Descriptions incorporated in the contract. The adequacy of HFE criteria which has been applied to work environments of operational and maintenance personnel should be verified. Life support criteria for critical operator functions should also be verified (See paragraph 3.2.2.3, Mil-H-46855).

Updated function and task allocation studies (HFE Block 29a) should now provide the basis for detailed prediction of likely sources of human error within the system. These predictions should be compared with hazard analyses and other safety studies performed by system safety engineering personnel. These two sources of data, when integrated, should provide for an early assessment of man/machine safety which should be further verified during system and subsystem testing.

Areas involving critical safety factors should be valuable inputs during the preparation of technical publications and the conduct of system training. The results of such studies are also provided as inputs to the preliminary design of operational, maintenance, support and facility end items. (HFE Blocks 29c and 29d).

BLOCK 29c - PARTICIPATE IN PRELIMINARY DESIGN OF OPERATIONAL SYSTEMS AND EQUIPMENT

HFE Responsibility

Designated by contractor

Output

Preliminary design recommendations

Summary

Review HFE requirements of the development contract

Study tentative design concepts

Consider applicable task allocation data

Identify incompatibilities (if any)

Propose design alternatives

Personnel designated by the contractor review the HFE requirements of the development contract and then study the tentative design concepts proposed by the contractor's engineering resources. The twin assurances which must be made in this block are that:

a. HFE equipment specifications (either of performance or configuration) can be incorporated in or met by the CEI's which would result if the tentative design concepts were adopted.

b. Human performance requirements created by the tentative design concepts are clearly identified and are in consonance with the findings determined in HFE Block 29a.

To satisfy those assurances it may be necessary to construct mockups or models to facilitate verification of task groups or substantiation of a configuration's capability of satisfying human engineering requirements of the contract. The design of information displays or control

devices for the human operator should be in accordance with appropriate military standards and specifications but should also consider the specific operator requirements developed in HFE Block 29a.

If incompatibilities exist between HFE requirements and the contractors tentative design concepts, design alterations should be proposed. If several configurations appear satisfactory, trade-off and/or simulation studies should be conducted to determine which design approach best satisfies HFE requirements while still meeting the criteria of maintainability, reliability, and value engineering.

During the course of preliminary design, it is important that the personnel performing the work in this block maintain close liaison with the personnel performing the work in HFE Blocks 29e and f so that decisions made or information uncovered in one area may be immediately checked for impact on the other areas.

BLOCK 29d - PARTICIPATE IN PRELIMINARY DESIGN OF MAINTENANCE, SUPPORT, AND FACILITY END ITEMS

HFE Responsibility

Designated by contractor

Output

Preliminary design recommendations

Summary

Review technical requirements of the contract

Assure incorporation of HFE criteria in design

Develop HFE mockups

Evaluate subcontractor and GFE data

Identify design alternatives

Provide recommendations for tradeoff studies

The activities conducted in this block are substantially the same as those carried out in HFE Block 29c, except that the emphasis is on the design of maintenance, support and facility end items. It is implicit in the definition of maintenance and support equipment that all equipment used at organizational, direct support, general support, and depot levels of maintenance has HFE requirements which must be met.

It is incumbent upon HFE system design personnel to maintain a continuous relationship with personnel charged with developing system personnel requirements. In this manner the data developed for updating the QQPRI (LCMM Block 117, and HFE Block 29e) should reflect the latest design approaches. The maintenance of this relationship should also have a direct impact upon the quality of data provided by HFE personnel as inputs to the Maintenance Support Plan (LCMM Blocks 112 and 117).

In support of the above activity it is necessary that HFE personnel participate in assessing the quantities of equipment and personnel required to maintain the system. The impact of the design on the quantity of equipment, personnel, and spares required should be obtained by correlating the required maintenance and support equipment, personnel, and spares with the maintenance functions. Subsequently, recommendations for the frequency of utilization of maintenance and support requirements by maintenance location, and the quantity of equipment required to support a given force structure are developed.

BLOCK 29e - UPDATE PERSONNEL REQUIREMENTS STUDIES

HFE Responsibility

Designated by contractor

Output

Inputs to Updated QQPRI

Summary

Review technical requirements of the contract

Update manpower and skill levels

Develop recommendations for tradeoffs as required

Provide inputs to development of POMM's

Prepare inputs to updated QQPRI

Personnel designated by the contractor review the alterations to the System Description and the Development Descriptions to ascertain their impact on the Provisional QQPRI developed in LCMM Block 34 and amplified in HFE Block 20b. The updated function and task allocation studies carried out in HFE Block 29a, and the system design activities in HFE Blocks 29c and 29d necessarily constitute an essential input for the development of revised manpower requirements and skill levels.

It is conceivable that conflicts may arise between personnel requirements, training plans and equipment, system design considerations, as well as with maintainability, reliability, and other system effectiveness interests. These conflicts should result in recommendations for tradeoff studies to be conducted in HFE Block 29h.

Additionally, inputs are made to the development of Preliminary Operating and Maintenance Manuals (POMM's) from the standpoint of criteria for readability, information content, and format, based upon anticipated skill requirements of the system.

BLOCK 29f - UPDATE TRAINING STUDIES AND TRAINING EQUIPMENT REQUIREMENTS

HFE Responsibility

Designated by contractor

Output

Revised training and training equipment requirements

Summary

Review technical requirements of the contract

Conduct studies as required

Update training requirements

Develop recommendations as required

Personnel designated by the contractor review the alterations to the System Description and the Development Descriptions to ascertain their impact upon the training program and training equipment requirements developed in HFE Block 20c. Changes to function and task allocations and verified task groups made in HFE Block 29a may necessitate revisions to the training program.

Additionally, modifications to required personnel skill levels and new system or equipment requirements will result in changes to both the training plans and training equipment. For example, if the requirements for an aircraft landing gear have undergone a major change in complexity from the standpoint of hydraulic system design, the original requirement for an animated panel trainer may no longer be valid. This information, along with recently acquired government studies of similar aircraft systems, may reveal that a part-task subsystem trainer is more suitable than the animated panel. It is therefore essential that the constant flow of information between HFE groups be maintained at this critical stage of development. Resolution of specific conflicts between technical approaches will become the subject of tradeoff studies to be accomplished in HFE Block 29h.

Specific studies will be carried out with respect to trainer characteristics, ranging from such subjects as trainer fidelity and malfunction duplication capability to instructor console design (if the trainer is a system simulator). It is therefore mandatory that results of training and/or trainer requirements studies be coordinated with the appropriate system design groups.

Inputs to the development of Preliminary Operating and Maintenance Manuals (POMM's) are provided, based upon studies which result in delineation of critical training problems and/or require critical operator tasks.

BLOCK 29g - UPDATE HFE TESTING REQUIREMENTS

HFE Responsibility

Designated by contractor

Output

Revised HFE testing requirements

Summary

Review technical requirements of the contract

Update test plans

Coordinate human error analyses and predictions

Personnel designated by the contractor review the alterations to the System Description and the Development Descriptions to ascertain their impact upon the HFE tests described in the CTP. It will be necessary for HFTE personnel to review updated function and task data (HFE Block 29a) in order that likely sources of human error are identified and scheduled for evaluation during qualification and developmental testing. Human error analyses should be coordinated with safety, reliability, maintainability and system design personnel.

BLOCK 29h - CONDUCT HFE TRADE-OFF STUDIES

HFE Responsibility

Designated by contractor

Output

Report of results of trade-off studies and analyses

Summary

Review technical requirements of the contract

Study results of HFE Preliminary Design effort

Conduct HFE trade-off studies as required

Provide HFE inputs to broad system engineering trade-offs

Personnel designated by the contractor review the alterations to the System Description and the Development Descriptions to ascertain the extent to which requirements have changed since the Contract Definition Phase (Phase B) began. Outputs from all HFE groups during Preliminary Design provide the impetus for trade-off studies required for resolving technical problems, and arriving at design decisions which best satisfy the intent of the contract.

For example, in a hypothetical aircraft system, several design alterations for displays may be available, all of which meet contract requirements. However, only through actual simulation may the optimum display method, from the standpoint of accuracy of reading, ease of interpretation, etc., be determined. Similarly, conflicts between value engineering and HFE and maintainability and HFE may be resolved through thorough parametric studies having the objective of determining which alternative(s) provide for the safest and most efficient human performance.

Three-dimensional mockups are used to determine compatibility with anthropometric, vision, and operability requirements. In addition, mockups are used for establishing placement and accessibility of equipment and verifying operator and maintenance personnel performance requirements.

The results of work performed in HFE Blocks 29a, b, c, d, e and f may prove to be incompatible from the standpoint of integrating all manpower characteristics into an optimum system design, thereby satisfying contractual requirements. For example, task performance or workload requirements may require a specific skill level, which is indeed reflected in the updated QQPRI. However, the design complexity may require excessive training time. A case in point might be the requirements for the copilot/gunner of a three-man armed helicopter to have a sophisticated terrain avoidance radar system requiring full manual control. Training specialists may object on the grounds that the equipment complexity introduces the need for highly specialized training courses for the operator, as well as excessive training time. The problem then becomes one of accepting the training burden or simplifying the operator's task through equipment redesign. One result of such a trade-off study would be to increase the degree of automation of the terrain avoidance radar system by removing the need for full manual control. Thus, the desired objective of reducing training time might be realized. The results of such a trade-off would be summarized for submittal to the government in the HFE Block 34.

Although it is emphasized that intra-HFE trade-offs must be accomplished during Preliminary Design, this in no way obviates the need for HFE inputs to be made in broader system trade-off studies. Consequently, it may be necessary for a total HFE point of view to be "traded off" against other system engineering interests.

BLOCK 30 - PREPARE HFE SUMMARY AND RECOMMENDATIONS

HFE Responsibility

Contractor

Output

Report delineating HFE Preliminary Design effort

Summary

Review HFE Preliminary Design effort

Prepare detailed HFE report which:

Summarizes HFE effort during Preliminary Design

Demonstrates compliance with contract requirements

Includes updated inputs to QQPRI

The contractor will prepare a detailed report summarizing the total HFE effort conducted during Preliminary Design. This involves updated analyses, studies, and tradeoffs conducted by System Design, Personnel Requirements, Training and HFE Testing and Evaluation groups. Recommendations for continued and/or additional studies, analyses, simulation, and testing are included. In addition, recommendations for redesign are presented together with their rationale.

One of the primary purposes of the summary report, however, is to provide the government with an overall visibility of contractor HFE performance. Thus, full substantiation must be provided to demonstrate that the system, in its existing state of development, satisfies human performance requirements of the contract.

A specific output of this phase, which will be fully covered in the detailed report, entails a second iteration of personnel requirements studies to update the QQPRI (LCMM Block 117). In addition, inputs for total Maintenance Requirements (LCMM Block 112) constitute another section of the report.

BLOCK 31 - CONDUCT HFE SYSTEM PRELIMINARY DESIGN REVIEW

HFE Responsibility

HFE Support Team

Output

Evaluation of contractor HFE Preliminary Design effort

Summary

Conduct periodic review of contractor data and design inputs

Maintain management and technical visibility

Assess contractor HFE performance during Preliminary Design

Establish HFE position for Preliminary Design Characteristics IPR

The HFE Support Team examines the HFE Summary Report developed in HFE Block 30 in order to determine the HFE status of the project and to assess the contractor's performance during the Preliminary Design effort. It should be emphasized that although a formal briefing should be given by the contractor prior to the Preliminary Design Characteristics IPR, this in no way precludes the HFE Support Team from conducting periodic meetings with the contractor throughout the Preliminary Design effort. Scheduling of these meetings is accomplished in HFE Block 28.

The HFE Support Team must become fully cognizant of all HFE work performed so that the government position with respect to HFE can be coordinated and consolidated as required with other applicable agencies prior to the Preliminary Design Characteristics IPR.

BLOCK 32 - PARTICIPATE IN PRELIMINARY DESIGN CHARACTERISTICS IPR

HFE Responsibility

HFE Support Team

Output

HFE briefing for IPR

Summary

Review contractor's HFE effort during Preliminary Design

Study results of HFE System Preliminary Design Review

Determine current status of project and problems

Prepare briefing for IPR

Provide HFE information and advice as required

The preliminary design characteristics IPR is an informal IPR (as contrasted to a formal IPR in AR 705-5, para 3-4) and as such is held only if called by the Project Manager or the developing agency at the request of representatives of the participating commands or agencies.

In the event that the IPR is held, the HFE Support Team prepares for it by reviewing the contractor's HFE effort during preliminary design (HFE Blocks 29-30) and studying the results of the HFE System Preliminary Design Review conducted in HFE Block 31.

Prior to the IPR the HFE Support Team determines the status of the project as being either "satisfactory" or "unsatisfactory" in each of the four general areas (design, personnel, training, testing). Significant problems are noted and, where possible, solutions proposed or courses of action recommended. A formal briefing should then be prepared covering the above information.

The team should insure adequate representation at the IPR to provide on-the-spot information or advice in any of the four HFE areas.

BLOCK 33 - HFE DETAIL DESIGN EFFORT

HFE Responsibility

Contractor

Output

HFE input to detail design of system and related maintenance, support, and facilities end items

Summary

Update data and studies

Provide inputs to detail designs

Personnel designated by the contractor perform the work necessary to assure design compliance with HFE requirements of the contract. The HFE effort for Detail Design differs from that for Preliminary Design in that the HFE effort now is primarily directed to detail drawings to be used in developing production descriptions and quality assurance provisions for end items, component hardware, and facilities. This is not only to assure the application of HFE principles and practices in the design, but to assure that systems and equipment meet human engineering requirements of the contract. The HFE effort may rely more heavily upon tests and evaluations to support design decisions and to demonstrate contract compliance.

Also, detailed task and workload studies are conducted and finalized prior to the Prototype System Characteristics IPR (HFE Block 40). In addition, detailed studies are conducted in response to either recommendations made by the government in HFE Block 31 or requirements which may have been specified during the preliminary Design Characteristics IPR (HFE Block 32).

It should be emphasized that, although Detail Design effort may terminate with LCMM Block 121, the HFE effort may extend through testing so as to assure incorporation of HFE requirements in Engineering Change Proposals.

BLOCK 33a - CONDUCT DETAIL TASK AND WORKLOAD STUDIES

HFE Responsibility

Designated by contractor

Output

Report of detailed task and workload studies

Summary

Review HFE Support Team design recommendations

Conduct detailed task and workload studies

Provide task and workload data during HFE tests

The work to be conducted in this block is similar in nature to HFE Block 29a, with the exception that detailed task and workload studies are performed to define more fully operator/system interfaces, and to demonstrate compliance with HFE portions of the contract. Emphasis is given to performing original time line and link analyses, updating previous analyses, and to establishing verified task groups. Engineering Change Proposals are also studied to determine their impact upon verified task groups.

It is incumbent upon HFE personnel assigned to this task to assure the availability of detailed task and workload data during HFE tests so that man-equipment interfaces can be verified prior to design release.

BLOCK 33b - PARTICIPATE IN DETAIL DESIGN OF OPERATIONAL SYSTEMS AND EQUIPMENT

HFE Responsibility

Designated by contract

Output

Detail design recommendations

Summary

Review HFE Support Team design recommendations

Assure incorporation of HFE criteria in design

Construct HFE mockups as required

Evaluate subcontractor and GFE data

Identify design alternatives

Provide recommendations for tradeoff studies

Personnel designated by the contractor perform the work necessary to assure design compliance with HFE requirements of the contract.

Emphasis is given to reviewing HFE Support Team design recommendations and/or requests for alteration (HFE Blocks 31 and 32) in order to assure resolution of technical problems.

The work to be conducted in this block is similar in nature to HFE Block 29c with the exception that HFE requirements are incorporated in detail drawings and layouts, and HFE approval of the design must be accomplished prior to design release. This, then, makes it mandatory that system design personnel fully coordinate all HFE requirements, to assure that the design is compatible with verified task groups, and that HFE testing completely substantiates design decisions.

ECP's are reviewed to determine their impact upon HFE contractual requirements, and recommendations are made for tradeoff studies (HFE Block 33g) as are deemed necessary.

More detailed mockups are utilized to resolve critical HFE design problems and for identifying design alternatives which are acceptable to all HFE interests.

BLOCK 33c - PARTICIPATE IN DETAIL DESIGN OF MAINTENANCE, SUPPORT AND FACILITY END ITEMS

HFE Responsibility

Designated by contractor

Output

Detail design recommendations

Summary

Review HFE Support Team design recommendations

Assure incorporation of HFE criteria in design

Construct HFE mockups as required

Evaluate subcontractor and GFE data

Identify design alternatives

Provide recommendations for tradeoff studies

Personnel designated by the contractor perform the work necessary to assure design compliance with HFE requirements of the contract. Emphasis is given to reviewing HFE Support Team design recommendations, and/or requests for alteration (HFE Blocks 31 and 32) in order to assure resolution of technical problems.

The work to be conducted in this block is similar in nature to HFE Block 29d with the exception that HFE requirements are incorporated in detail drawings and layouts, and HFE approval must be accomplished prior to design release. This, then, makes it mandatory that system design personnel fully coordinate all HFE requirements to assure that the design is compatible with verified task groups, and that HFE testing completely substantiates design decisions.

ECP's are reviewed to determine their impact upon HFE contractual requirements, and recommendations are made for tradeoff studies as are deemed necessary.

More detailed mockups are utilized to resolve critical HFE design problems, and for identifying design alternatives which are acceptable to all HFE interests.

BLOCK 33d - CONDUCT DETAIL PERSONNEL REQUIREMENTS STUDIES

HFE Responsibility

Designated by contractor

Output

Report of detail personnel requirement studies

Summary

Review HFE Support Team design recommendations

Conduct detailed studies needed to establish final QQPRI

Prepare inputs to maintenance literature

Personnel designated by the contractor perform the detail studies needed to ultimately establish the final QQPRI (LCMM Block 156) and inputs to the maintenance literature finalized in LCMM Block 155.

The work to be conducted in this block is similar in nature to the work accomplished in HFE Block 29e with two exceptions. First, emphasis is applied to the determination of the impact of design changes established in HFE Blocks 33b and c upon system personnel requirements. Second, since the updated QQPRI submitted in LCMM Block 117 has resulted in a tentative MCS decision (LCMM Block 119), work can proceed on a more detailed level to assist development of technical publications.

Inputs are also provided to HFE training specialists so that coordinated recommendations can be submitted for the NET Advanced Individual Training Plan (LCMM Block 122).

BLOCK 33e - CONDUCT DETAIL TRAINING AND TRAINING EQUIPMENT STUDIES

HFE Responsibility

Designated by contractor

Output

Revised training and training equipment requirements

Summary

Review HFE Support Team recommendations

Assure incorporation of HFE criteria in training plans and equipment

Provide inputs to POMM's

Personnel designated by the contractor perform the detailed studies needed for establishing final New Equipment Training plans in LCMM Block 123.

The work to be conducted in this block is similar in nature to the work accomplished in HFE Block 29f, with the exception that detailed studies may be required in order to resolve technical problems raised in the government review of the HFE Preliminary Design effort (HFE Block 31). Also, it is important that the results of detailed studies be furnished to technical publications groups so that special or critical training problems can be fully explained in the text of POMM's, thereby assisting in personnel training.

BLOCK 33f - CONDUCT DETAILED HFE TESTS; UPDATE INPUT TO CTP

HFE Responsibility

Designated by contractor

Output

Report of HFE test results

Summary

Review technical recommendations of HFE Support Team

Update test plans as required

Conduct HFE tests and evaluations

Personnel designated by the contractor perform the tests and evaluations required and support operational analyses to verify task groups.

The work to be performed in this block is similar in nature to the work accomplished in HFE Block 29g with the notable exception that more actual testing is conducted concurrent with hardware availability. The major purpose of such HFE tests and evaluations is to confirm the predictions made during Preliminary Design of human error likelihood for each CEI having a man/machine interface. The basis for conducting the tests will be the detailed task and workload studies conducted in HFE Block 33a, as well as the inputs from other HFE groups (HFE Blocks 33b through e).

In addition, updated inputs to the CTP will be provided if required.

BLOCK 33g - CONDUCT HFE TRADE-OFFS

HFE Responsibility

Designated by contractor

Output

Report of results of trade-off studies and analyses

Summary

Review HFE Support Team recommendations

Study results of HFE Detail Design effort

Conduct HFE trade-off studies as required

Provide HFE inputs to broad system engineering trade-offs

Personnel designated by the contractor perform the trade-off studies as required. The work to be conducted in this block is similar in nature to the work accomplished in HFE Block 29h. One exception to this is the fact that Engineering Change Proposals (ECP's) will be anticipated even after the prototype system is available. Thus, trade-off studies become an important element in developing design decisions as ECP's for additional or revised system requirements are generated and implemented.

The personnel responsible for the work in this block will also insure that HFE implications are made clear in other trade-offs being conducted in other specialty areas.

BLOCK 34 - PREPARE HFE SUMMARY AND RECOMMENDATIONS

HFE Responsibility

Contractor

Output

Report delineating HFE Detail Design effort

Summary

Review HFE Detail Design effort

Prepare detailed HFE report which

Summarizes HFE effort during Detail Design

Demonstrates compliance with contract requirements

Includes inputs to training plans and CTP

The contractor will prepare a detailed report summarizing the total HFE effort conducted during Detail Design. This involves updated analyses, studies, trade-offs, and results of tests conducted by the HFE personnel. Recommendations for continued and/or additional tests are presented.

One of the primary purposes of the summary report, however, is to provide the government with an overall visibility of contractor HFE performance. Thus, full substantiation must be provided to demonstrate that the system, in its existing state of development, satisfies human factors engineering requirements of the contract.

Specific outputs of this phase which will be fully covered in the detailed report entails an input to the training plans prepared in LCMM Block 123, as well as inputs to the CTP as required.

BLOCK 35 - CONDUCT HFE SYSTEM DETAIL DESIGN REVIEW

HFE Responsibility

HFE Support Team

Output

Evaluation of contractor HFE Detail Design effort

Summary

Conduct periodic review of contractor data and design inputs

Maintain management and technical visibility

Assess Contractor HFE performance during Detail Design

Establish HFE position for Detail Design Characteristics IPR

The HFE Support Team examines the HFE Summary Report developed in HFE Block 34 in order to determine the HFE status of the project and to assess the contractor's performance during the Detail Design effort. It should be emphasized that although a formal briefing should be given by the contractor prior to the Detail Design Characteristics IPR, this in no way precludes the HFE Support Team from conducting periodic meetings with the contractor throughout the Detail Design effort. Scheduling of these meetings is accomplished in HFE Block 28.

The extent to which the HFE Support Team will participate in the monitoring and evaluation of New Equipment Training should be established here and reflected in the plans of LCMM Blocks 123 and 124.

The HFE Support Team must become fully cognizant of all HFE work performed so that the government position with respect to HFE can be coordinated and consolidated as required with other applicable agencies prior to the Detail Design Characteristics IPR.

BLOCK 36 - PARTICIPATE IN DETAIL DESIGN CHARACTERISTICS IPR

HFE Responsibility

HFE Support Team

Output

HFE briefing for IPR

Summary

Review contractor's HFE effort during Detail Design

Study results of HFE System Detail Design Review

Determine current status of project and problems

Prepare briefing for IPR

Provide HFE information and advice as required

The Detail Design Characteristics IPR is an informal IPR (as contrasted to a formal IPR in AR 705-5, para 3-4) and as such is held only if called by the Project Manager or the developing agency at the request of representatives of the participating commands or agencies.

In the event that the IPR is held, the HFE Support Team prepares for it by reviewing the contractor's HFE effort during Detail Design (HFE Block 33-34), and studying the results of the HFE System Detail Design Review conducted in HFE Block 35.

Prior to the IPR the HFE Support Team determines the status of the project as being either "satisfactory" or "unsatisfactory" in each of the four general areas (design, personnel, training, testing). Significant problems are noted and, where possible, solutions proposed or courses of action recommended. A formal briefing should

then be prepared covering the above information. The team should insure adequate representation at the IPR to provide on-the-spot information or advice in any of the four HFE areas.

BLOCK 37 - UPDATE HFE INPUT TO COORDINATED TEST PLAN (CTP) FOR DEVELOPMENT ACCEPTANCE TESTS (DAT)

HFE Responsibility

HFE Support Team

Output

Revised HFE input to CTP for DAT

Summary

Review Coordinated Test Plan

Coordinate and consolidate updated test plan inputs

Finalize test schedules, instrumentation and data requirements

Finalize contractor HFE test support requirements

The purpose of the work in this block is to finalize the HFE portion of the CTP and to insure that it is as complete and concise as possible. There are two primary objectives of the HFE portions of the DAT: (1) the measurement of total system performance as a function of each man-machine interaction, and (2) the systematic examination of each CEI for which HFE specifications have been made. When both objectives are realized, all task groups (each of which delineates a system personnel position) can be verified and the human engineering of CEI's can be assured.

The HFE Support team reviews and updates the Coordinated Test Plan for the conduct of HFE tests during Development Acceptance Tests. The nature, scope and adequacy of HFE plans and tests will be reviewed to determine the need for additions or deletions to the DAT. Inputs from all HFE Support Team member agencies will be coordinated and consolidated to assure that unnecessary duplication is

avoided during DAT. Specific schedules, test instrumentation, and data requirements will be developed for integration in the DAT Plans. Arrangements for contractor support of HFE tests will be finalized subsequent to coordination with the contractor.

The overall HFE input will delineate specific HFE tests to be conducted during Engineering Design Tests (EDT), Engineering and Service Tests, and Production Acceptance Tests.

Inasmuch as results of the HFE portions of the Design Acceptance Tests may require changes to equipment configuration, it is important that the major portion of HFE testing be accomplished as early as possible in the testing cycle. Consequently, the HFE Support Team will insure that no testing or evaluation which can be accomplished effectively in the EDT environment is delayed for later integration into ET/ST.

BLOCK 37a - SYSTEM DESIGN REQUIREMENTS

HFE Responsibility

Determined in HFE Block 37

Output

Requirements for system design oriented tests during DAT

Summary

Review system design progress and problems

Review Coordinated Test Plan

Finalize requirements for tests and evaluations during DAT

Finalize test support equipment requirements

Designated members of the HFE Support Team review the progress and problems of the system designers (reported in HFE Block 34) with reference to HFE portions of the CTP (last updated in HFE Block 33f). Modifications are then made as required to HFE portions of the CTP to insure the adequacy of testing of (1) each problem area, (2) all verified task groups, and (3) each CEI for which HFE specifications have been written.

Additionally, consideration will be given to tests and evaluations of:

a. Effect of equipment arrangement on crew efficiency, including such items as internal information flow.

b. Communications efficiency.

c. Adequacy of handling and transporting equipment, and procedures therefor.

d. Identification of design features prejudicial to proper maintenance and operation.

e. Identification of design features or procedures which constitute a hazard to safety of system personnel.

f. Identification of error-inducing design features of the equipment.

g. Adequacy of identification, sequencing and time-phasing of tasks.

Additionally, specific test equipment and/or instrumentation requirements and data collection procedures will be finalized.

BLOCK 37b - PERSONNEL REQUIREMENTS

HFE Responsibility

Determined in HFE Block 37

Output

Requirements for personnel-oriented tests during DAT

Summary

Review personnel progress and problems

Review Coordinate . Test Plan

Finalize requirements for tests and evaluations during DAT

Finalize test support equipment requirements

Designated members of the HFE Support Team review the progress and problems of the project (reported in HFE Block 34) with respect to personnel and then review the HFE portions of the CTP (last updated in HFE Block 33f). Modifications are then made as required to HFE portions of the CTP to insure the adequacy of testing or evaluation of each problem area and the following general areas:

a. Adequacy of types and number of specialists for manning.

b. Analysis of task performance requirements for improvement of efficiency.

c. Adequacy of task description to reveal skill and knowledge requirements, environmental conditions, tools and equipment, frequency of task performance and time for performance.

d. Adequacy of grouping of tasks by position to permit application of homogeneous quantification requirements for personnel selection and training.

e. Effectiveness of organization and utilization of personnel.

f. Sufficiency of QQPRI data.

Additionally, specific test equipment and/or instrumentation requirements and data collection procedures will be finalized.

BLOCK 37c - TRAINING REQUIREMENTS

HFE Responsibility

Determined in HFE Block 37

Output

Requirements for training-oriented tests during DAT

Summary

Review training progress and problems

Review Coordinated Test Plan

Finalize requirements for tests and evaluations during DAT

Finalize test support equipment requirements

Designated members of the HFE Support Team review the progress and problems of the project (repeated in HFE Block 34) with respect to training and then review the HFE portions of the CTP (last updated in HFE Block 33f). Modifications are then made as required to HFE portions of the CTP to insure the adequacy of testing or evaluation of each problem area and the following general areas:

a. Adequacy of training and training equipment coverage in relation to detailed task performance requirements.

b. Sufficiency of training courses, devices, and equipment to accomplish the intended function in support of human performance.

c. Adequacy of manuals in setting forth job instructions for operation and maintenance of the system.

d. Verification of technical manuals and related job aids.

Additionally, specific test equipment and/or instrumentation requirements and data collection procedures will be finalized.

BLOCK 37d - TEST AND EVALUATION REQUIREMENTS

HFE Responsibility

Determined in HFE Block 37

Output

HFE input to CTP for DAT

Summary

Review Coordinated Test Plan

Study HFE test and evaluation requirements developed by system design, personnel, and training areas

Prepare consolidated input to CTP for DAT

HFE test and evaluation requirements developed in HFE Blocks 37a, b, and c are critically reviewed by HFTE personnel to assure non-duplication of test instrumentation, data collection procedures, and specific requirements. The HFE inputs to the DAT must reflect a coordinated and consolidated position. If necessary, trade-offs must be accomplished to determine priorities of specific tests, and to determine efficacy of certain test equipment and/or data collection procedures.

Test criteria, methods and procedures will be evaluated, as well as data to be collected, and the data collection techniques to be utilized. Plans for government personnel and facilities required for testing, composition of HFTE data collection team, and provisions for data analysis and utilization of test results, will be established.

BLOCK 38 · PARTICIPATE IN ENGINEERING DESIGN TEST

HFE Responsibility

HFE Support Team

Output

Analyses of data; preliminary findings and recommendations

Summary

Conduct HFE portion of EDT

Reduce and analyze test data

Prepare preliminary findings and recommendations

Prepare contractor evaluation report

The HFE Support Team participates in Engineering Design Testing in accordance with the plans finalized in HFE Block 37d. Even though operational analyses (to verify task groups) should already have been performed by the contractor(s), EDT provides the Army with the first formal, full-scale test of the contractor's design theory. Since it has been well established that design changes resulting from tests are less apt to be as costly if discovered early in developmental testing, it is desirable that the bulk of HFE testing be conducted at this time, if possible. Occasionally, however, the Project Manager may permit EDT to be conducted on a component or sub-system level. When this decision is made, much of the HFE testing described in the succeeding blocks cannot be accomplished and will have to be held up until ET/ST.

Designated members of the HFE Support Team augmented by specified government and contractor resources conduct the HFE portion of EDT. Inasmuch as test data will usually be analyzed separately by design, personnel and training areas (and often by different government agencies), it is desirable that representatives of each interest or agency assist in or observe the collection of test data.

When data from each of the major areas of HFE have been analyzed and preliminary findings and recommendations prepared, the full HFE Support Team meets (in HFE Block 39) to prepare the final coordinated HFE position.

EDT is usually also an occasion for the HFE Support Team to submit a contractor evaluation report in accordance with the Evaluation Plan of the project (see HFE Block 17). The format for this report is prescribed by the Project Manager, but usually included are assessments not only of to what extent the contractor has met the HFE provisions of the contract, but also of the manner of his performance.

BLOCK 38a - CONDUCT HFE PORTION OF EDT

HFE Responsibility

Determined in HFE Block 38

Output

Raw test data

Summary

Perform systematic examination of designated CEI's

Measure system performance by man-machine interface units

Obtain and report qualitative and quantitative data

Designated members of the HFE Support Team and other, supporting personnel conduct the HFE portion of EDT in accordance with the CTP. In general, there are two major efforts:

a. The systematic examination of model or prototype CEI's which will be involved with any human performance in operation or maintenance and for which HFE specifications have been made. The purpose of these examinations is to determine whether the relevant HFE specifications have been met and whether undesireable design features have been introduced.

b. Operational analyses conducted on the same model or prototype CEI's to determine whether the task group defining each personnel position can be verified and whether the HFE performance specifications have been met.

Attention will be given both to accuracy in the gathering of quantitative data and to completeness in the preparation of qualitative descriptions of observed phenomena. Data sheets will be furnished to the appropriate HFE agencies for analysis as soon as practicable after completion of testing. Technical or methodological problems encountered in the collecting of data will be described and furnished to the personnel performing the work in HFE Block 38e.

BLOCK 38b - ANALYZE TEST DATA; UPDATE OR VERIFY SYSTEM DESIGN REQUIREMENTS

HFE Responsibility

Determined in HFE Block 38

Output

Updated system design requirements

Summary

Reduce and analyze raw test data

Isolate problem areas and recommend solutions

Identify additional testing requirements

Update HFE system design requirements

Designated members of the HFE Support Team and other, supporting personnel reduce and analyze the sets of data provided them from HFE Block 38a. Verification of task groups (to include determination that tasks are clearly and adequately defined and suitably sequenced and time phased) and workload, time line, and human error analyses are normally performed at this time. Problem areas are identified, specific problems isolated, and--hopefully--their cause(s) ascertained.

A solution should then be proposed for each problem. Where more than one solution is available, the merits of each should be explored (to include cost and desirability from the HFE point of view). Design solutions to problems should be worked out completely to permit determination of the probable effects (if any) of the proposed changes on the remainder of the system.

Specific, additional HFE testing requirements for the system or any of its components should be clearly identified and provided to the personnel performing the work in HFE Block 38e.

HFE requirements for system design should be updated to reflect the information learned from EDT.

BLOCK 38c - ANALYZE TEST DATA; UPDATE OR VERIFY PERSONNEL REQUIREMENTS

HFE Responsibility

Determined in HFE Block 38

Output

Updated personnel requirements

Summary

Reduce and analyze raw test data

Isolate problem areas and recommend solutions

Identify additional testing requirements

Update personnel requirements

Designated members of the HFE Support Team and other, supporting personnel reduce and analyze the sets of data provided them from HFE Block 38e. The extent to which QQPRI data have been verified is determined, but this determination must also take into account the degree to which the test personnel and environment were representative of the potential military user population and the likely conditions under which the system will be employed.

In general, the analysis of data in this block will be concerned with determining whether the number and types of personnel allotted to operate and maintain the system are adequate and whether the proposed unit organization will be operationally effective and make efficient use of personnel. Problem areas should be identified, specific problems isolated, and--hopefully--their causes ascertained.

A solution should then be proposed for each problem. Where more than one solution is available, the merits of each should be explored (to include cost and desirability from the HFE point of view). Enough information on which to base analyses or recommendations for changes

BLOCK 38c - ANALYZE TEST DATA; UPDATE OR VERIFY PERSONNEL REQUIREMENTS

HFE Responsibility

Determined in HFE Block 38

Output

Updated personnel requirements

Summary

Reduce and analyze raw test data

Isolate problem areas and recommend solutions

Identify additional testing requirements

Update personnel requirements

Designated members of the HFE Support Team and other, supporting personnel reduce and analyze the sets of data provided them from HFE Block 38e. The extent to which QQPRI data have been verified is determined, but this determination must also take into account the degree to which the test personnel and environment were representative of the potential military user population and the likely conditions under which the system will be employed.

In general, the analysis of data in this block will be concerned with determining whether the number and types of personnel allotted to operate and maintain the system are adequate and whether the proposed unit organization will be operationally effective and make efficient use of personnel. Problem areas should be identified, specific problems isolated, and--hopefully--their causes ascertained.

A solution should then be proposed for each problem. Where more than one solution is available, the merits of each should be explored (to include cost and desirability from the HFE point of view). Enough information on which to base analyses or recommendations for changes

in manning is sometimes unavailable--often due to test orientation or limitations. In such cases, additional testing designed to provide the missing information should be proposed and forwarded to the personnel performing the work in HFE Block 38e.

Personnel requirements should be updated to reflect the information learned from EDT.

in manning is sometimes unavailable--often due to test orientation or limitations. In such cases, additional testing designed to provide the missing information should be proposed and forwarded to the personnel performing the work in HFE Block 38e.

Personnel requirements should be updated to reflect the information learned from EDT.

BLOCK 38d - ANALYZE TEST DATA; UPDATE OR VERIFY TRAINING REQUIREMENTS

HFE Responsibility

Determined in HFE Block 38

Output

Updated training requirements

Summary

Reduce and analyze raw test data

Isolate problem areas and recommend solutions

Identify additional testing requirements

Update training requirements

Designated members of the HFE Support Team and other, supporting personnel reduce and analyze the sets of data provided them from HFE Block 38a. Major considerations during the analyses involve determinations that:

a. Training plans, courses or aids which the contractor may have been required to produce are technically correct, comply with the provisions of the contract, and are adequate for the purpose for which they were designed.

b. Training material achieves maximum efficiency and effectiveness from minimum necessary time and cost.

c. Training standards are set high enough to produce technically qualified personnel without wasting training developing proficiency beyond that necessary for efficient job performance.

d. Technical publications used for or in training are accurate and effective.

Problem areas in training should be identified, specific problems isolated, and--hopefully--their causes ascertained. A solution should then be sought for each problem. In those cases where insufficient information is available on which to base analyses or propose changes in training, additional testing requirements designed to provide the missing information should be formulated and provided to the personnel performing the work in HFE Block 38e.

Training requirements should be updated to reflect the information learned from EDT.

BLOCK 38e - IDENTIFY FUTURE HFE TEST AND EVALUATION REQUIREMENTS

HFE Responsibility

Determined in HFE Block 38

Output

Revisions to HFE portion of CTP

Summary

Review HFE testing planned for ET/ST

Collect and coordinate additional testing requirements

Revise HFE portion of CTP as required

The purpose of the work in this block is to insure the completeness of HFE testing of the system by reviewing the adequacy of and measurement problems encountered during EDT. Additional testing requirements determined in HFE Blocks 38b, c and d are collected and coordinated, and necessary revisions made to the HFE plans for ET/ST. Methodological problems reported in HFE Block 38a are studied to improve techniques and procedures for subsequent testing.

BLOCK 39 - PREPARE HFE SUMMARY AND RECOMMENDATIONS

HFE Responsibility

HFE Support Team

Output

(Immediate) Report of findings and recommendations

(Subsequent) Report of HFE participation in EDT

Summary

Identify system problems

Coordinate recommended solutions

Plan for additional testing

Prepare brief of findings and recommendations

Prepare final test report

The purpose of the work in this block is to bring before the full HFE Support Team the problems discovered and the solutions proposed in HFE Blocks 38b, c and d so that a coordinated set of HFE findings and recommendations can be prepared. During the meeting(s) of the full team care should be taken to insure that:

a. All of the system problems are identified. It may appear that phenomena reported in two areas (e.g., design and training) are reflections of one problem which is perhaps amenable to a design solution. In actuality, however, the phenomena may be the result of two or more distinct HFE problems having only one or more points of commonality (e.g., both occurring in human performance on one CEI).

b. Solutions agreed upon by the full team have been sufficiently thoroughly thought out that new problems (either for HFE or other engineering specialties) would not be created by their acceptance.

When a particular problem appears to be amenable to solution by any of redesign, personnel selection or training, it may be necessary to conduct a limited trade-off study to ascertain the relative feasibility and cost-effectiveness of each solution.

The revisions to the HFE plan for participation in ET/ST (prepared in HFE Block 38e) should also be reviewed at this time and concurrence received from all members of the HFE Support Team.

The team will insure that the HFE findings and recommendations from EDT are provided to the Project Manager on a timely basis. The team should also at this time begin work on the formal EDT report which will include detailed descriptions of test objectives, methods, procedures, data, results and analyses in addition to the findings and recommendations.

BLOCK 40 - PARTICIPATE IN PROTOTYPE SYSTEM CHARACTERISTICS IPR

HFE Responsibility

HFE Support Team

Output

HFE briefing for IPR

Summary

Review results of HFE Preliminary and Detail Design effort

Review results of HFE portion of EDT

Determine current status of project

Prepare briefing for IPR

Provide HFE information and advice as required

The HFE Support Team prepares for the IPR by reviewing all of the previous HFE effort during the Development and Production phase, especially that conducted during Preliminary and Detail Design, and during the Engineering Design Tests.

Prior to the IPR the HFE Support Team determines the status of the project as being either "satisfactory" or "unsatisfactory" in each of the four general areas (design, personnel, training, testing). Particular emphasis is placed on assessing the utility of the prototype hardware item(s) from an HFE viewpoint and preparing recommendations for modifications to the system if required.

A formal briefing should then be prepared covering the above information. The team should insure adequate representation at the IPR to provide on-the-spot information or advice in any of the four HFE areas.

BLOCK 41 - MONITOR AND EVALUATE NEW EQUIPMENT TRAINING

HFE Responsibility

HFE Support Team

Output

Recommendations for system changes

Summary

Monitor conduct of NET

Identify problems

Conduct trade-off studies (if required)

Propose changes in system design, personnel and training (as appropriate)

The HFE Support Team monitors New Equipment Training for three principal reasons:

a. to explore training problems early, while changes can still be made to all elements of the system;

b. to determine the adequacy and efficiency of the training;

c. to provide a perspective for interpreting test data.

The scope of these interests requires that the representation by the HFE Support Team during NET be broadly based so that problems identified can be viewed from design and personnel--as well as training--standpoints. Once problems have been identified, it may be necessary to conduct limited trade-off studies before solutions can be proposed.

The HFE Support Team should also insure that any contractor deliverable items concerning training (such as lesson plans and training aids) are adequate, meet HFE specifications, and are in consonance with the training concepts proposed by the government. Deficiencies should be brought to the attention of the Project Manager.

The experiences of the HFE Support Team during the monitoring of NET should also provide a useful perspective for interpreting test data (from HFE Blocks 38a and 42a) and in proposing system changes.

BLOCK 42 - PARTICIPATE IN DEVELOPMENT ACCEPTANCE TESTS

HFE Responsibility

HFE Support Team

Output

Analyses of data; preliminary findings and recommendations

Summary

Conduct HFE portion of ET/ST

Reduce and analyze test data

Prepare preliminary findings and recommendations

Prepare contractor evaluation report

The HFE Support Team participates in Engineering and Service Tests (ET/ST) in accordance with the plans finalized in HFE Block 38e. The amount of HFE work performed during ET/ST will largely be influenced by how much testing with satisfactory results was able to be accomplished during EDT (see HFE Block 38). Ideally, HFE efforts during ET/ST would concern only tests of corrections to the system made after EDT plus those tests designed specifically for the environment approximating operational conditions. However, any applicable testing described in HFE Block 37 which was not conducted in HFE Block 38a should now have been scheduled for ET/ST. Where the HFE effort is large during ET/ST, it is important that data analysis be completed as rapidly as possible so that sufficient time will be available to determine all of the ramifications of each system change which is recommended. The system description with the changes recommended by the HFE Support Team becomes the basis for production descriptions which, in turn, are used in contract negotiations in LCMM Block 177.

Designated members of the HFE Support Team augmented by specified government and contractor resources--and, if appropriate, in direct support of the Service Test Board involved--conduct the HFE portion of ET/ST. Inasmuch as test data will usually be analyzed separately by design, personnel and training areas (and often by different government agencies), it is desirable that representatives of each interest or agency assist in or observe the collection of test data.

When data from each of the major areas of HFE have been analyzed and preliminary findings and recommendations prepared, the full HFE Support Team meets (in HFE Block 43) to prepare the final, coordinated HFE position.

ET/ST is usually also an occasion for the HFE Support Team to submit a contractor evaluation report in accordance with the Evaluation Plan of the project (see HFE Block 17). The format for this report is prescribed by the Project Manager, but usually included are assessments not only of to what extent the contractor has met the HFE provisions of the contract, but also of the manner of his performance.

BLOCK 42a - CONDUCT HFE PORTION OF DAT (LESS EDT)

HFE Responsibility

Determined in HFE Block 42

Output

Raw test data

Summary

Perform systematic examination of designated CEI's

Measure system performance by man-machine interface units

Obtain and report qualitative and quantitative data

The HFE portion of the Engineering Test is usually concerned with the systematic examination of CEI's which will be involved with human performance in operation or maintenance and for which HFE specifications have been made. The purpose of these examinations is to determine whether (1) the relevant HFE specifications have been met, (2) any undesirable design features have been introduced, and (3) design changes recommended by the HFE Support Team and approved by the Project Manager have been satisfactorily made.

The HFE portion of the Service Test is concerned with human performance and system performance as affected by human performance. Operational analyses should be performed on task groups which have not yet been verified, the system and standards for selection and training of personnel for operation and maintenance should be examined, and the influence of the (sometimes simulated) operational environment on human performance should be assessed.

Attention will be given both to accuracy in the gathering of quantitative data and to completeness in the preparation of qualitative descriptions

of observed phenomena. Data sheets will be furnished to the appropriate HFE agencies for analysis as soon as practicable after completion of testing. Technological or methodological problems encountered in the collecting of data will be described and furnished to the personnel performing the work in HFE Block 42e.

BLOCK 42b - ANALYZE TEST DATA; UPDATE OR VERIFY SYSTEM DESIGN REQUIREMENTS

HFE Responsibility

Determined in HFE Block 42

Output

Updated system design requirements

Summary

Reduce and analyze raw test data

Isolate problem areas and recommend solutions

Identify additional testing requirements

Update system design requirements

Designated members of the HFE Support Team and other, supporting personnel reduce and analyze the sets of ET/ST data provided them from HFE Block 42a. Careful attention is given to the effect of the (simulated) operational environment upon human performance in each man-machine interface to insure that any reductions in the quality of human responses do not degrade system performance below required standards. Problem areas are identified, specific problems isolated, and--hopefully--their cause(s) ascertained.

A solution should then be proposed for each problem. Where more than one solution is available, the merits of each should be explored (to include cost and desirability from the HFE point of view). Design solutions to problems should be worked out completely to permit determination of the probable effects (if any) of the proposed changes on the remainder of the system.

Specific, additional HFE testing requirements for the system or any of its components should be clearly identified and furnished to the personnel performing the work in HFE Block 42e.

HFE requirements for system design should be updated to reflect the information learned from ET/ST.

BLOCK 42c - ANALYZE TEST DATA; UPDATE OR VERIFY PERSONNEL REQUIREMENTS

HFE Responsibility

Determined in HFE Block 42

Output

Updated personnel requirements

Summary

Reduce and analyze raw test data

Isolate problem areas and recommend solutions

Identify additional testing requirements

Update personnel requirements

Designated members of the HFE Support Team and other, supporting personnel reduce and analyze the sets of ET/ST data provided them from HFE Block 42a.

Ideally, the effort in this block will be concerned with verifying the numbers, types and organization of personnel in the system as the system is employed in a (simulated) operational environment. However, any necessary personnel selection work not accomplished during EDT or other efforts necessary to complete the final PQQPRI (in LCMM Block 156) should be performed at this time. Personnel problem areas should be identified, specific problems isolated, and--hopefully--their causes ascertained. A solution should then be proposed for each problem. If additional testing is required to validate recommended system personnel changes, the nature of such testing should be clearly developed and furnished to the personnel performing the work in HFE Block 42e.

Personnel requirements should be updated to reflect information learned from ET/ST.

BLOCK 42d - ANALYZE TEST DATA; UPDATE OR VERIFY TRAINING REQUIREMENTS

HFE Responsibility

Determined in HFE Block 42

Output

Updated training requirements

Summary

Reduce and analyze raw test data

Isolate problem areas and recommend solutions

Identify additional testing requirements

Update training requirements

Designated members of the HFE Support Team and other, supporting personnel reduce and analyze the sets of ET/ST data provided them from HFE Block 42a. The primary effort in this block is verification of the adequacy and efficiency of operations and maintenance training (to include a critical assessment of the efficacy of training aids and devices and all publications used in training). Training problem areas should be identified, specific problems isolated, and--hopefully--their causes ascertained.

A solution should then be proposed for each problem. If additional testing is required to validate recommended training changes, the nature of such testing should be made clear to the personnel performing the work in HFE Block 42e.

Training requirements should be updated to reflect information learned from ET/ST and in sufficient detail to prepare the training portion of the PQQPRI in LCMM Block 154.

BLOCK 42e - IDENTIFY FUTURE HFE TEST AND EVALUATION REQUIREMENTS

HFE Responsibility

Determined in HFE Block 42

Output

Revisions to HFE portion of CTP

Summary

Collect and coordinate additional testing requirements

Revise HFE portion of CTP as appropriate

Designated members of the HFE Support Team collect and coordinate additional testing requirements produced in HFE Blocks 42b, c and d and draft revisions to the HFE portion of the CTP as appropriate. In general, any additional HFE testing should be planned for the Production Acceptance Tests (HFE Block 48). However, in cases where time appears to be a vital factor or some aspect of system performance is still seriously in doubt, the HFE Support Team should request the Project Manager to authorize special tests of the system or the components involved.

BLOCK 43 - PREPARE HFE SUMMARY AND RECOMMENDATIONS

HFE Responsibility

HFE Support Team

Output

(Immediate) Report of findings and recommendations

(Subsequent) Report of HFE participation in ET/ST

Summary

Identify system problems

Coordinate recommended solutions

Plan for additional testing

Prepare brief of findings and recommendations

Prepare final test report

The purpose of the work in this block is to bring before the full HFE Support Team the problems discovered and the solutions proposed in HFE Blocks 42b, c and d so that a coordinated set of HFE findings and recommendations can be prepared. During the meeting(s) of the full team care should be taken to insure that:

a. All of the system problems are identified. It may appear that phenomena reported in two areas (e.g., design and training) are reflections of one problem which is perhaps amenable to a design solution. In reality, however, the phenomena may be the result of two or more distinct HFE problems having only one or more points of commonality (e.g., both occurring in human performance on one CEI).

b. Solutions agreed upon by the full team have been sufficiently thought out that new problems (either for HFE or other engineering specialties) would not be created by their acceptance.

When a particular problem appears to be amenable to solution by any of redesign, personnel selection or training, it may be necessary to conduct a limited trade-off study to ascertain the relative feasibility and cost effectiveness of each solution.

The proposals for additional HFE testing (prepared in HFE Block 42e) should also be reviewed at this time and concurrence received from all members of the HFE Support Team. Final details (to include personnel facilities and support) should be worked out and the HFE test proposal presented to the Project Manager for approval. Information uncovered during testing which concerns maintenance of the system should also be provided to the agency updating the Maintenance Support Plan (in LCMM Block 154).

The team will insure that the HFE findings and recommendations from ET/ST are forwarded to the Project Manager on a timely basis. The team should also at this time begin work on the formal ET/ST report which will include detailed descri_ions of test objectives, methods, procedures, data, results and analyses as well as the findings and recommendations.

BLOCK 44 - PARTICIPATE IN DEVELOPMENT ACCEPTANCE IPR

HFE Responsibility

HFE Support Team

Output

HFE briefing for IPR

Summary

Review results of HFE portion of DAT

Determine current status of project

Prepare briefing for IPR

Provide HFE information and advice as required

The HFE Support Team prepares for the IPR by reviewing the HFE effort conducted during the Development Acceptance Tests. Prior to the IPR, the team determines the status of the project as being either "satisfactory" or "unsatisfactory" in each of the four general areas (design, personnel, training, testing).

Particular emphasis is placed on assessing the utility of the evolved system from the HFE viewpoint, and preparing recommendations concerning the acceptability of the system for type classification Conditional Standard A, and initiation of the production phase.

A formal briefing should then be prepared covering the above information. The team should insure adequate representation at the IPR to insure on-the-spot information or advice in any of the four HFE areas.

BLOCK 45 - PREPARE FINAL HFE REPORT

HFE Responsibility

Contractor

Output

Final report of HFE effort during Development Phase

Summary

Prepare comprehensive report of all HFE activities during Development Phase

Submit development data for approval

Prepare briefing for Project Manager and HFE Support Team

Perform additional HFE studies as required

Provide input to HFE common data base

Personnel designated by the contractor prepare a final HFE report which summarizes the efforts and activities included in Preliminary and Detail Design, and those associated with support of DAT Testing. The report should be comprehensive and cover in detail all work performed by system design, personnel, training, and HFE test and evaluation specialists.

All HFE data formally required by the contract should be included in the report and submitted for government approval. Included are results of trade-off studies, and the manner in which design change recommendations resulting from tests have been implemented. All function and task group, QQPRI and training data should be included. The results of trade-off studies and dynamic simulations performed to resolve man-machine problems should be included in the report as well.

The contractor should prepare a briefing at which time the final report can be presented to the Project Manager and the HFE Support Team. It should be emphasized that this activity should take place prior to final government review of Production Descriptions and the subsequent contract negotiations (LCMM Block 177). This is to allow the HFE Support Team to conduct a thorough review of the report (HFE Block 46), and to effect changes prior to final government approval. Areas in the final report which are found to be deficient may provide the impetus for imposing additional or new requirements in the Production Descriptions.

The delivery and approval of the final HFE report should in no way preclude the contractor from performing additional HFE work on a continuing basis in order to demonstrate that system changes brought about by Engineering Change Proposals (ECP's) reflect HFE requirements. The report should demonstrate the extent to which HFE requirements of the contract have been met, and should demonstrate compliance with the contractor's HFE plan developed in HFE Blocks 14 and 15.

The major purpose of this report is to provide a vehicle for delivery to the government in one place all of the contractor's HFE data, decisions and information concerning the development of the system. Portions of the human performance data will ultimately be pooled in a common data bank for use by government HFE agencies in developing requirements for advanced systems. In addition, the report will provide a basis for the government's evaluation of contractor performance (in accordance with the Evaluation Plan of the project).

BLOCK 45a - SYSTEM DESIGN SUMMARY

HFE Responsibility

Designated by contractor

Output

System Design section of final HFE report

Summary

Prepare section of HFE Final Report which:

- Indicates degree of compliance with contractual requirements
- Explains rationale for design decisions
- Presents all function and task data
- Contains results of trade-off studies

Personnel designated by the contractor prepare a summary of all HFE activities related to the system design. Emphasis in this section will be in demonstrating compliance with HFE system design requirements, and delineating the extent to which departures from standard human engineering criteria and practices have been deemed necessary.

It is essential that the rationale for all major design decisions involving critical human performance in the system be fully described. Further, all function and task data (to include reports of operational analyses to verify task groups for operations and maintenance), and detailed workload, link, and time-line analyses shall be presented in a final form. Results of trade-off studies involving not only allied HFE elements, but other indicators of system effectiveness (reliability, maintainability, etc.) should be fully described.

In this way, the information is fed back to the HFE Support Team so that a critical assessment of the original requirements for the system may be made.

BLOCK 45b - PERSONNEL REQUIREMENTS SUMMARY

HFE Responsibility

Designated by contractor

Output

Personnel Requirements section of final HFE report

Summary

Prepare section of HFE Final Report which:

Indicates degree of compliance with contractor requirements

Presents all personnel requirements data

Contains results of studies and analyses

Personnel designated by the contractor prepare a summary of all HFE activities related to the establishment of personnel requirements for the operation and maintenance of the system. Emphasis in this section will be on demonstrating compliance with personnel requirements of the contract.

All data formally required by the contract should be included in the report to provide substantiation for establishment of duty positions, skill levels, and manning requirements for the system. All studies and analyses related to development of technical publications should also be included. The data are submitted for government review and comparison with HFE test results.

The major purpose of this section is to provide feedback to the HFE Support Team so that a critical assessment of the original HFE system requirements may be made.

BLOCK 45c - TRAINING REQUIREMENTS SUMMARY

HFE Responsibility

Designated by contractor

Output

Training Requirements section of final HFE report

Summary

Prepare section of HFE Final Report which:

- Indicates degree of compliance with contractual requirements
- Presents all training requirements data
- Contains results of trade-off studies

Personnel designated by the contractor prepare a summary of all HFE activities related to the system training program and training aids and devices development.

All data formally required by the contract should be included, particularly training requirements analyses, specific studies, and summary of inputs made to training plans, technical manuals, and trainer design. Also, results of trade-off studies in which training was considered should be described.

In this way, the information is fed back to the HFE Support Team so that a critical assessment of the original requirements for the system may be made.

BLOCK 45d - HFE TEST AND EVALUATION SUMMARY

HFE Responsibility

Designated by contractor

Output

HFE Test and Evaluation section of final HFE report

Summary

Prepare section of HFE Final Report which:

Indicates degree of compliance with contractual requirements

Presents results of HFE tests

Personnel designated by the contractor prepare a summary of all HFE tests conducted during system development. Emphasis will be in delineating the results of specific tests which demonstrated HFE requirements of the contract.

Statements should be included on test methods and procedures, type of data collected, data collection techniques, and samples of checklists, questionnaires, etc., provided. Implications of significant test findings for the system should be described in addition to statements of limitations of test results.

In this way, the information is fed back to the HFE Support Team so that a critical assessment of the original requirements for the system may be made.

BLOCK 46 - REVIEW FINAL HFE REPORT

HFE Responsibility

HFE Support Team

Output

Contractor Evaluation Report

Summary

Study contractor's Final HFE Report

Adjudge adequacy of total contractor HFE effort

Prepare Contractor Evaluation Report

Conduct self-assessment

The HFE Support Team reviews the contractor's Final HFE Report (prepared in HFE Block 45) to make an overall assessment of the contractor's HFE program during system development. The assessment will cover matters both technical (evaluating the adequacy and accuracy of the work performed) and administrative (evaluating such items as the maintenance and availability of HFE data files). The assessment will serve as the basis for a Contractor Evaluation Report which will be prepared in accordance with the Evaluation Plan of the project (see HFE Block 17).

The contractor's Final HFE Report will also be studied to determine the necessity for recommending to the Project Manager that additional HFE requirements be included in the production contract.

The contractor's Final HFE Report should also provide one basis for a self-assessment by the HFE Support Team. The adequacy and accuracy of technical work and the coordination and timeliness of team operations during Contract Definition and Development should be examined. In this regard it is often appropriate to prepare an informal report of "lessons learned" which could be used by other HFE Support Teams in future projects.

BLOCK 47 - ADVISE PROJECT MANAGER AS REQUIRED

HFE Responsibility

HFE Support Team

Output

HFE provisions for production contract

HFE input to CTP for PAT

Information and recommendations to Project Manager as required

Summary

Prepare HFE provisions of production contract (if required)

Provide for HFE participation in PAT (as appropriate)

Provide HFE information and recommendations (as required)

Requirements for changes to the HFE provisions of the production contract may have arisen from an analysis of the contractor's Final HFE Report (HFE Block 46) or from system changes directed in the Development Acceptance IPR and SSE (LCMM Blocks 166-167). The preparation of the HFE provisions of the production contract should be accomplished at this time following in general the procedures described in HFE Block 24.

It is important that, if the production configuration of the system differs markedly from the configuration previously subjected to HFE testing, HFE participation be scheduled in the Production Acceptance Tests. The scope of this participation should ordinarily be limited to verification of those system improvements made since ET/ST; however, within that scope there should be no constraints upon the adequacy of the testing. The CTP should be updated as appropriate and HFE test provisions inserted in the development contract if required.

The Project Manager may request HFE assistance during actual contract negotiations--particularly when there have been HFE changes made to the production descriptions. Also, contractors may have counter-proposals to make to HFE requirements which would require fast and accurate appraisal. The HFE Support Team insures availability to the Project Manager of the necessary information and assistance.

BLOCK 48 - PARTICIPATE IN PRODUCTION ACCEPTANCE TESTS

HFE Responsibility

HFE Support Team

Output

Analyses of data; preliminary findings and recommendations

Summary

Conduct HFE testing as appropriate

Reduce and analyze data

Prepare initial findings and recommendations

The HFE Support Team participates in the Production Acceptance Tests in accordance with the CTP (as updated in HFE Block 47). In general, the effort in this block is limited to the retesting for verification purposes of equipment which has been altered since ET/ST to meet HFE specifications and the validation of changes to personnel selection or training procedures.

Designated members of the HFE Support Team augmented by specified government and contractor resources conduct the HFE portion of PAT. Data are furnished to the appropriate HFE agencies where reduction and analysis are conducted and preliminary findings and recommendations determined.

BLOCK 49 - PREPARE HFE SUMMARY AND RECOMMENDATIONS

HFE Responsibility

HFE Support Team

Output

(Immediate) Report of findings and recommendations

(Subsequent) Report of HFE participation in PAT

Summary

Identify remaining system problems (if any)

Coordinate recommended solutions

Prepare brief of findings and recommendations

Prepare contractor evaluation report (if required)

Prepare final test report

The full HFE Support Team meets to review the initial findings and recommendations produced in HFE Block 48 and to establish an HFE position concerning the initiation of full-scale production. The analyses of PAT data are reviewed to identify any remaining system problems. A solution for each such problem will be proposed and coordinated among all of the government agencies represented on the HFE Support Team, and the appropriate recommendation(s) immediately furnished to the Project Manager.

If HFE participation in PAT was extensive, a contractor evaluation report should be prepared in accordance with the Evaluation Plan of the project (see HFE Block 17). The report should be limited to the time frame since the last contractor evaluation report and should indicate with specific information those areas in which contractor performance has been deficient.

At this time the HFE Support Team should also begin work on the formal PAT report which will include detailed descriptions of test objectives, methods, procedures, data, results and analyses as well as the findings and recommendations.

BLOCK 50 - PARTICIPATE IN PRODUCTION VALIDATION IPR

HFE Responsibility

HFE Support Team

Output

HFE briefing for IPR

Summary

Review results of HFE participation in PAT

Determine current status of project

Prepare briefing for IPR

Provide HFE information and advice as required

The HFE Support Team prepares for the IPR by reviewing any HFE work conducted since the completion of the Development Acceptance Tests, especially the results of HFE participation in the Production Acceptance Tests (HFE Block 48). Prior to the IPR, the team determines the status of the project as being either "satisfactory" or "unsatisfactory" in each of the four general areas (design, personnel, training, testing).

Particular emphasis is placed on assessing the utility of the produced system from the HFE viewpoint, and preparing recommendations concerning the acceptability of the system for final type classification Standard A, initiation of full scale production, and entry into the operational phase.

A formal briefing should then be prepared covering the above information. The team should insure adequate representation at the IPR to provide on-the-spot information or advice in any of the four HFE areas.

APPENDIX

REFERENCE PUBLICATIONS

ARMY REGULATIONS

1-110	Contracting for Management, Operations Research and Automatic Data Processing Services, Studies, and Projects, 22 Jan 68
11-25	The Management Process for Development of Army Systems, 10 Apr 68
70-8	Human Factors and Social Sciences Research
70-10 (Draft)	Test and Evaluation During Development and Acquisition of Materiel
70-17	System/Project Management, 19 Jan 68
71-1	Army Combat Developments, 27 May 66
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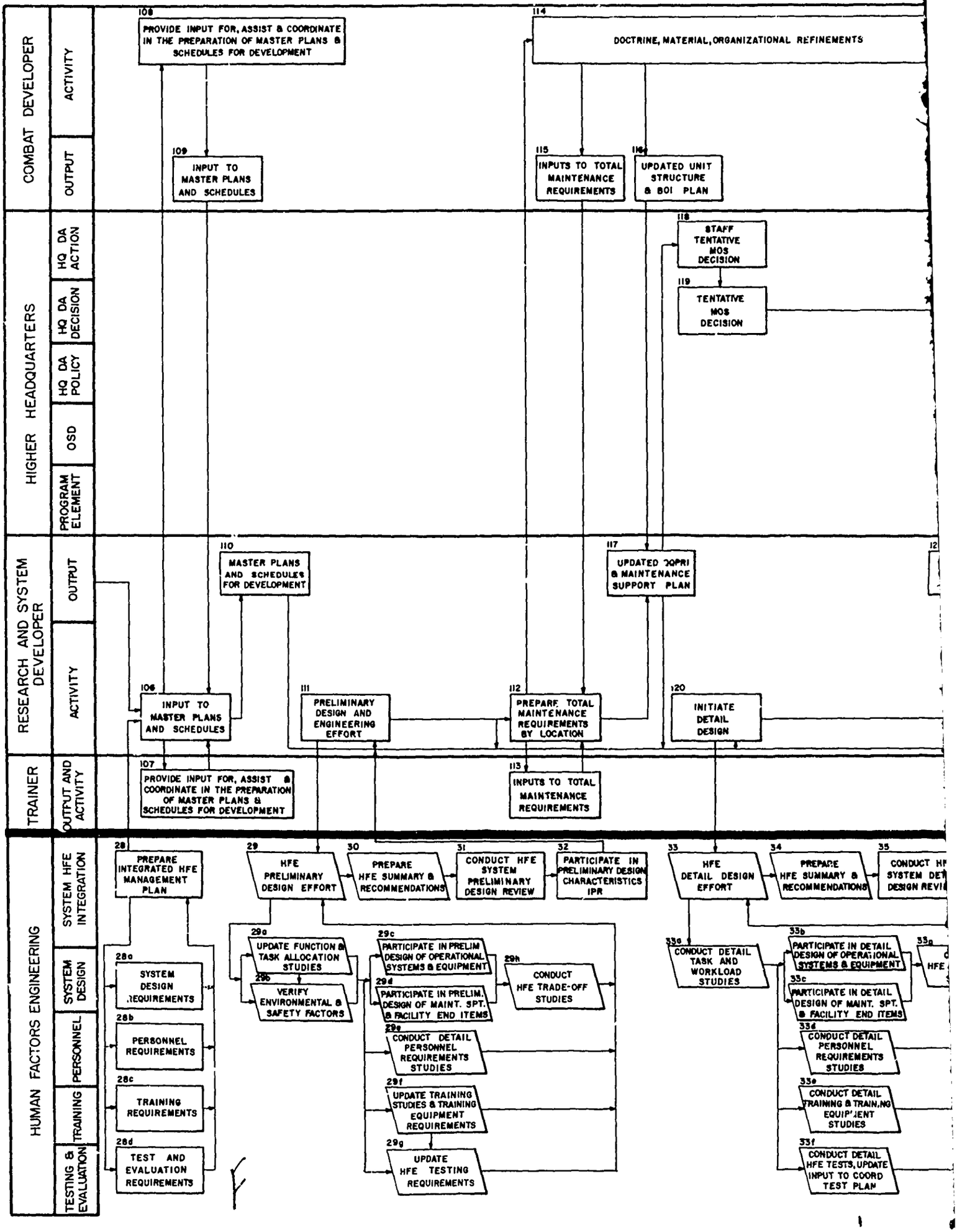
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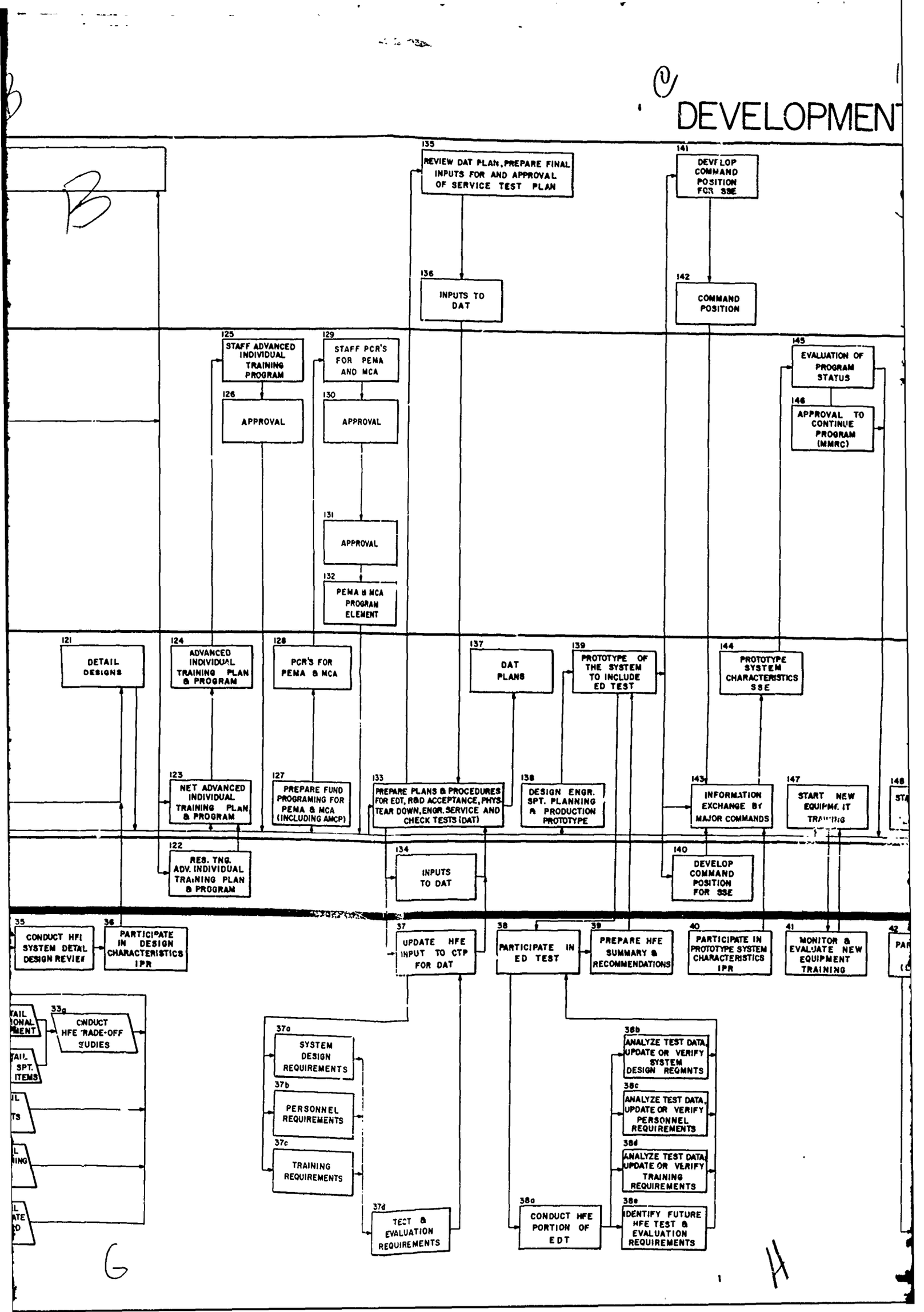
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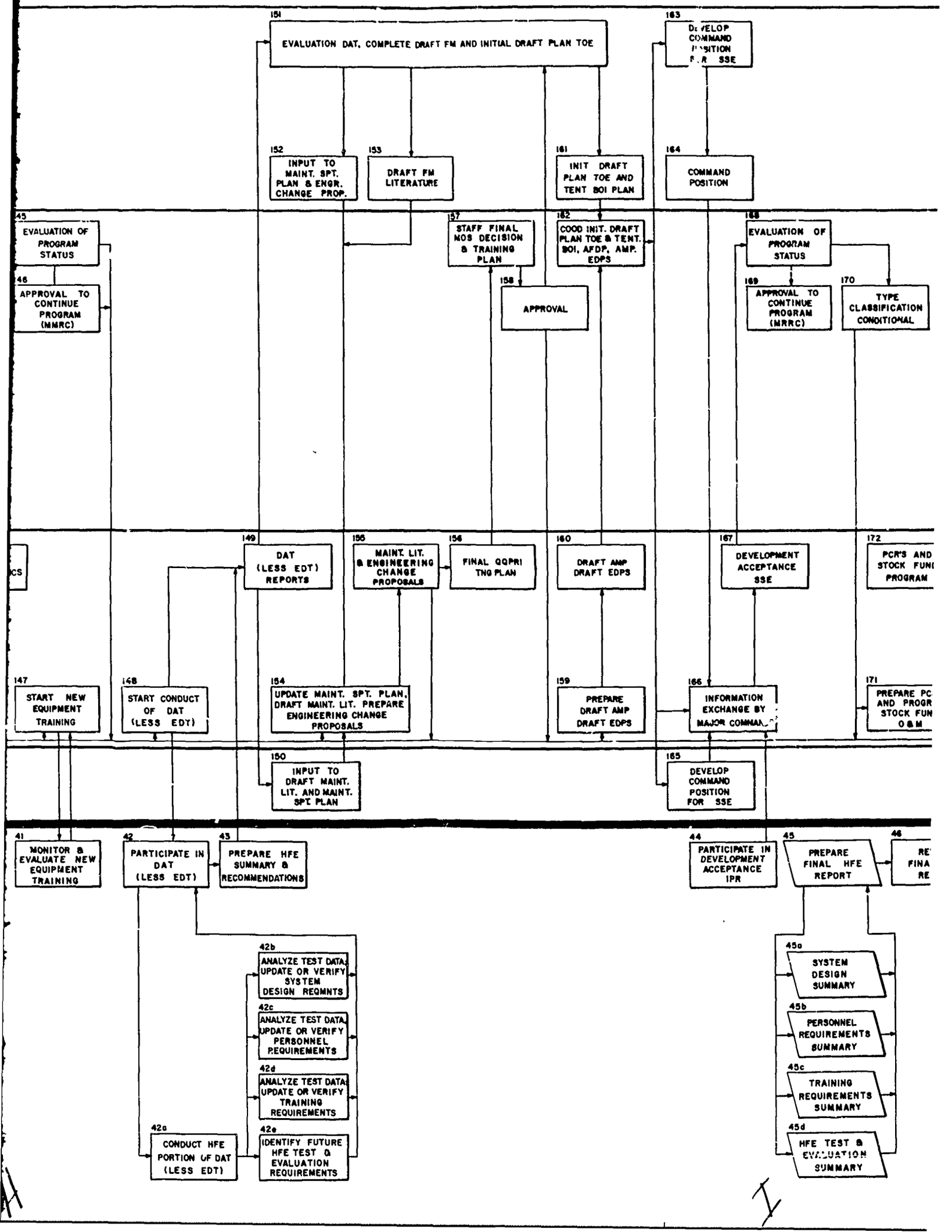

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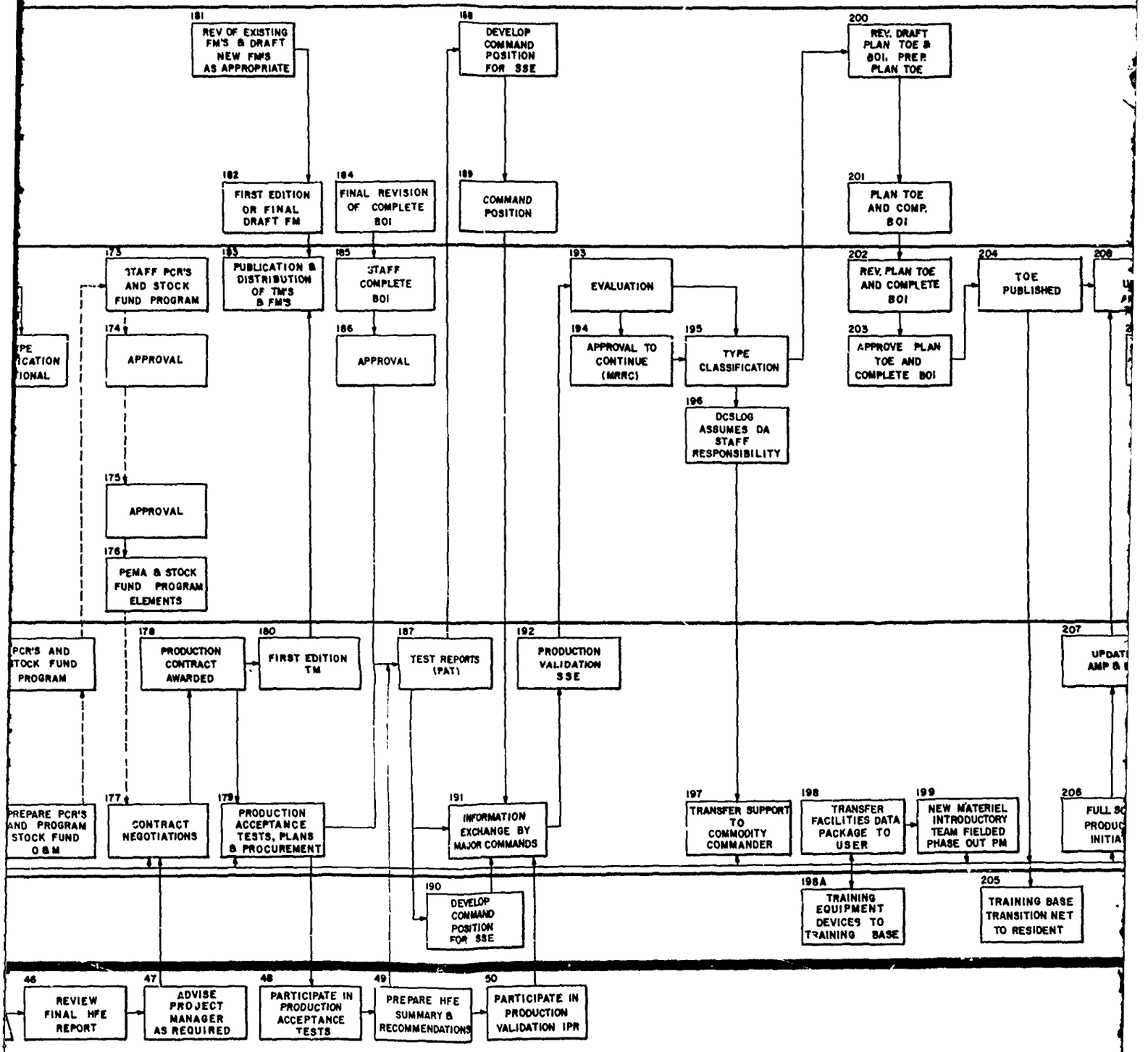
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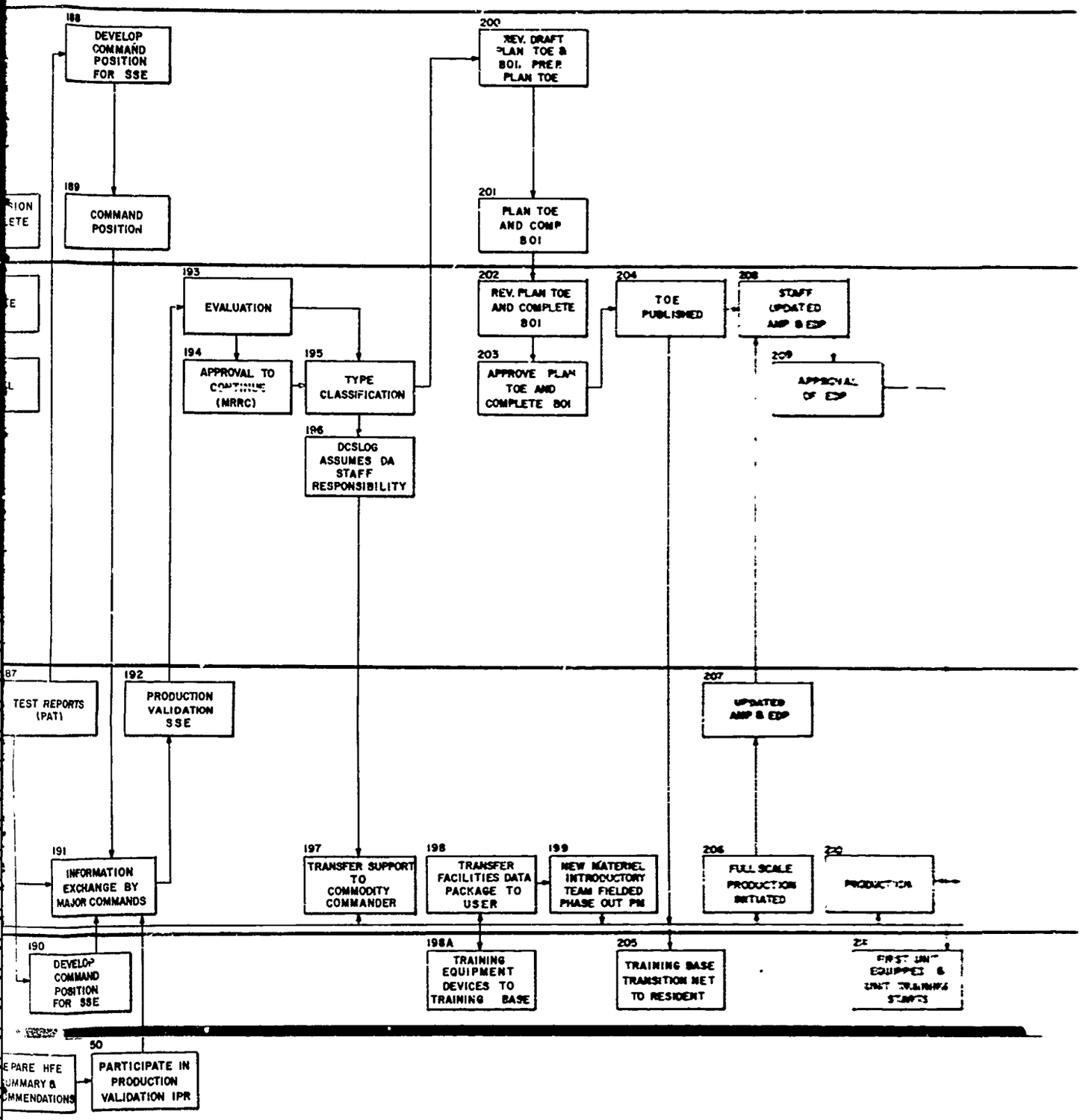
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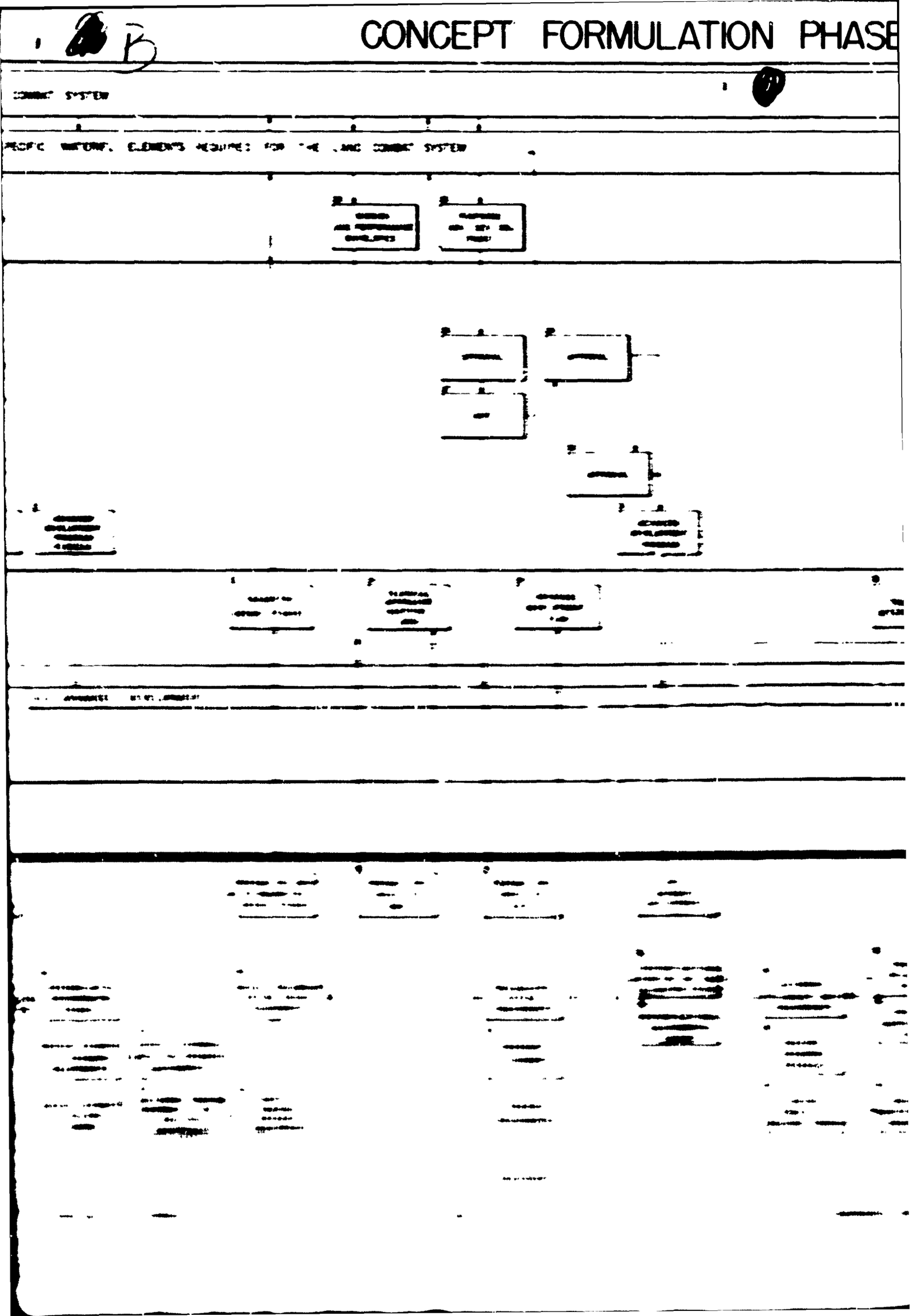

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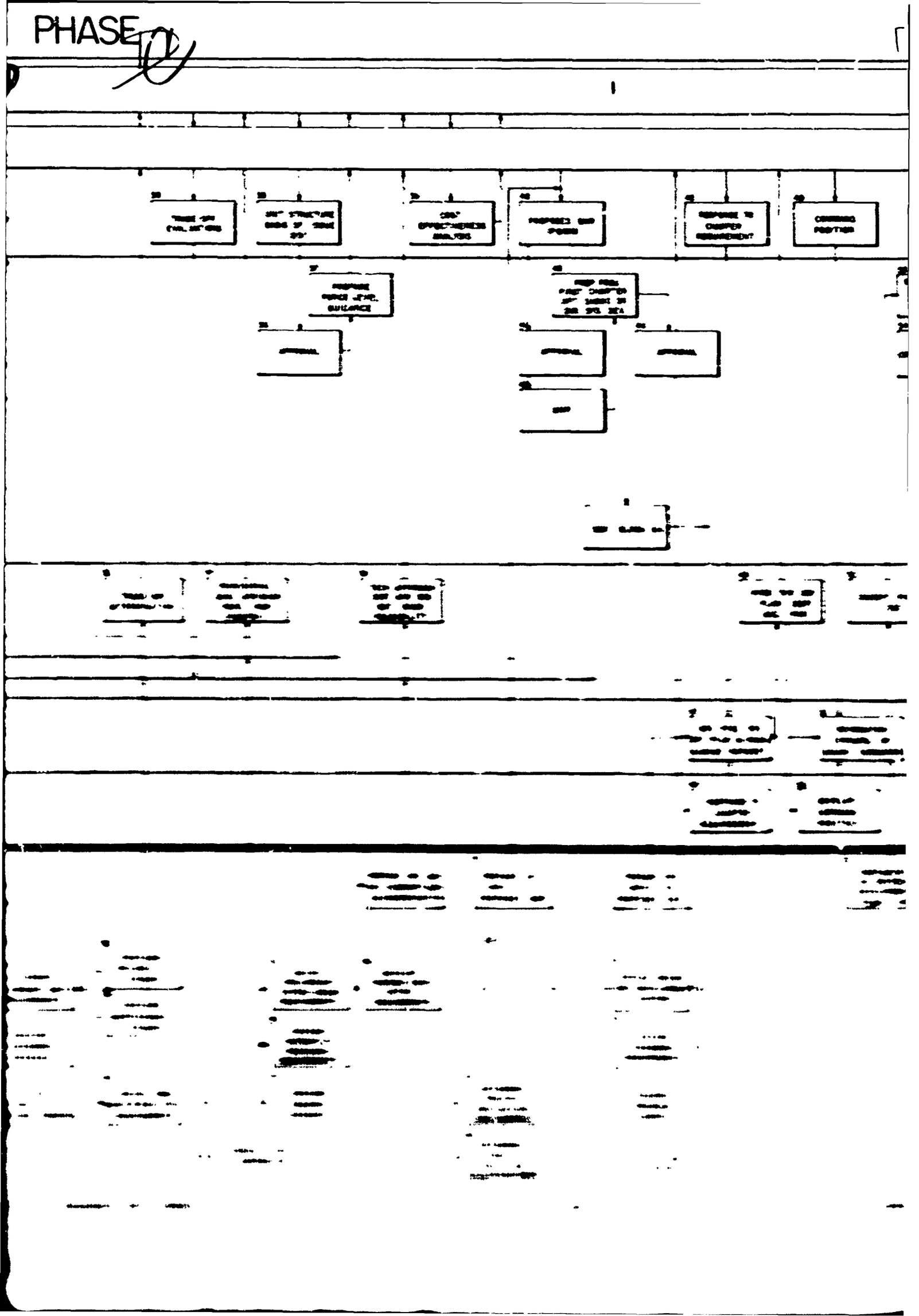

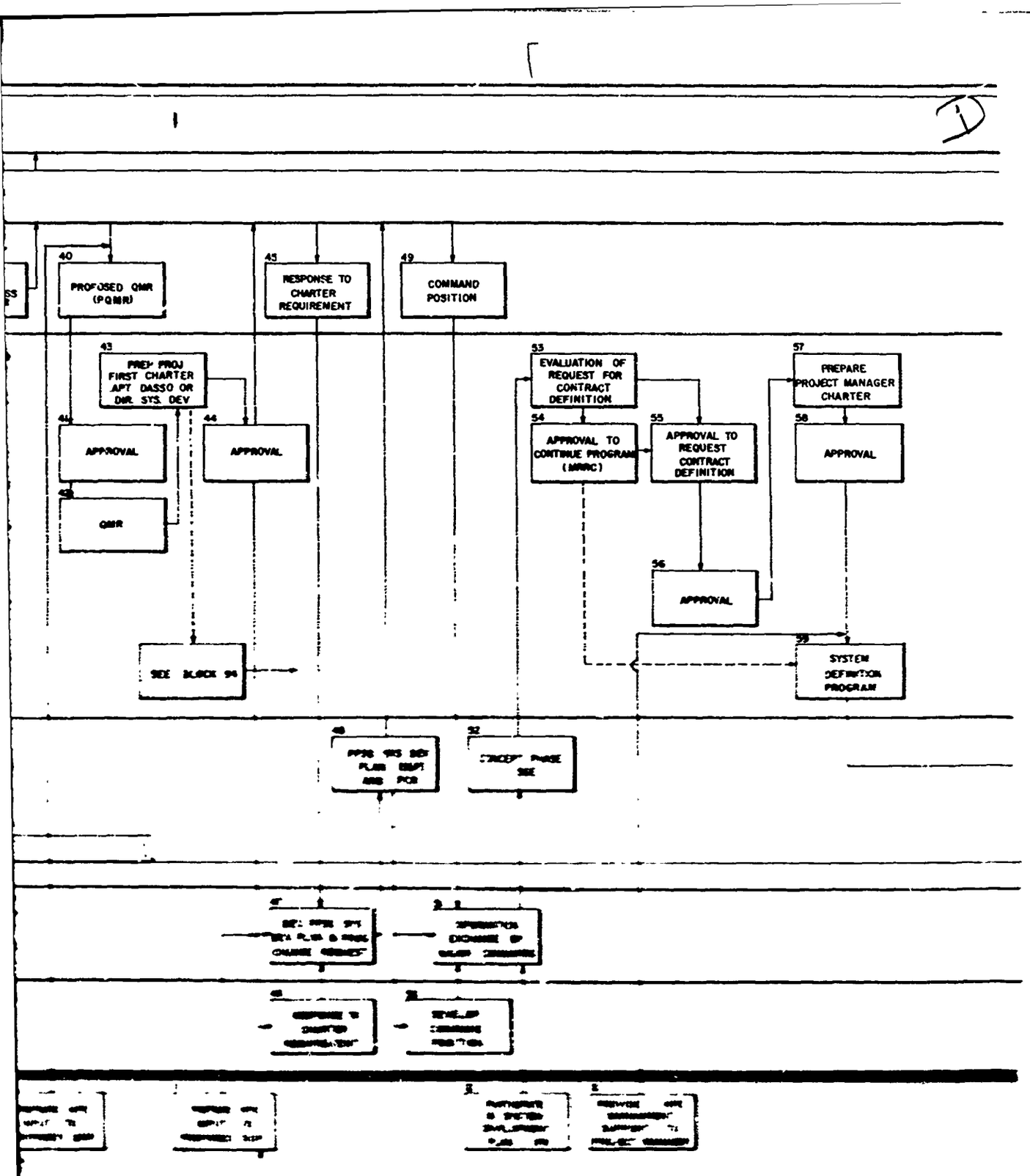
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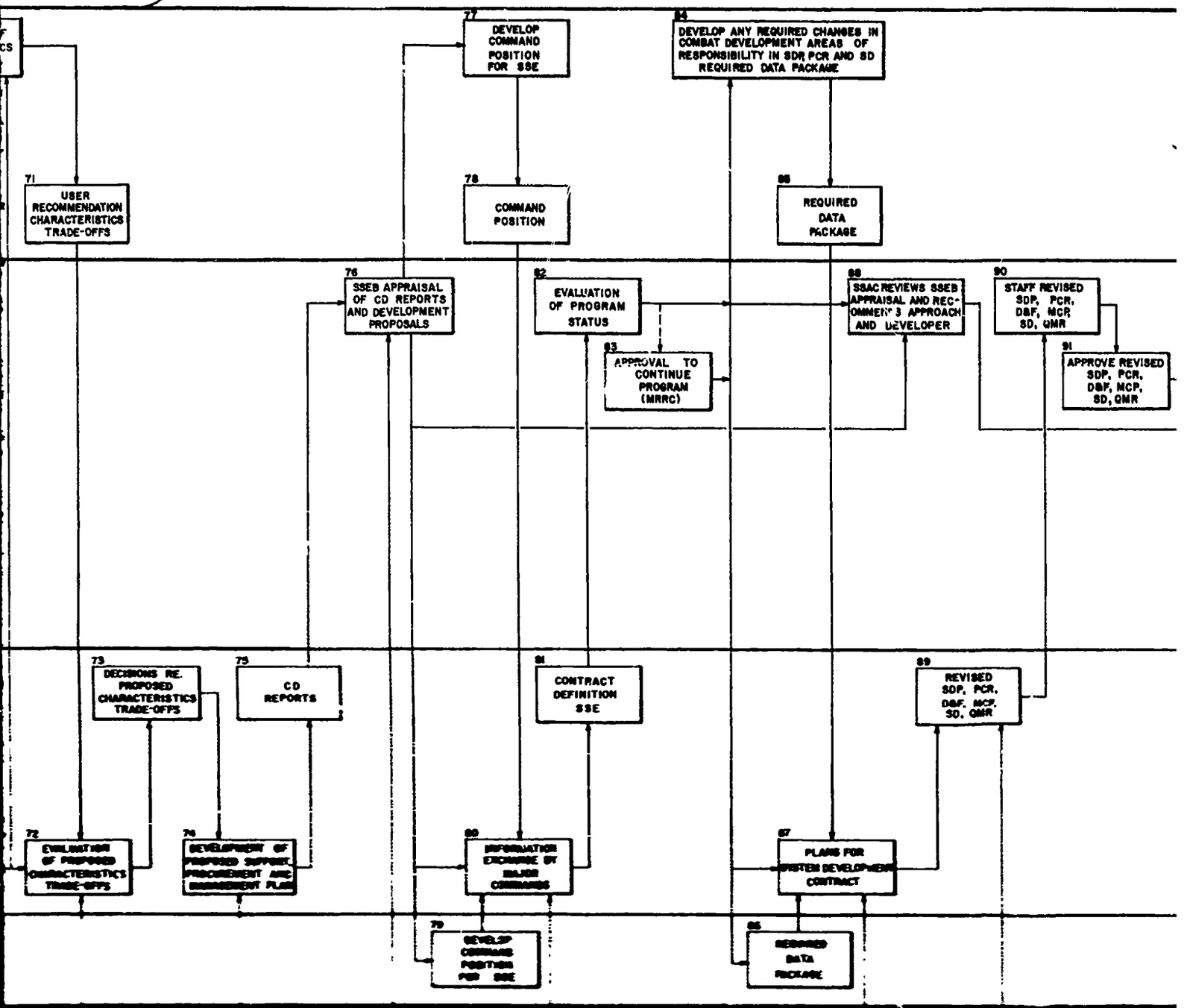

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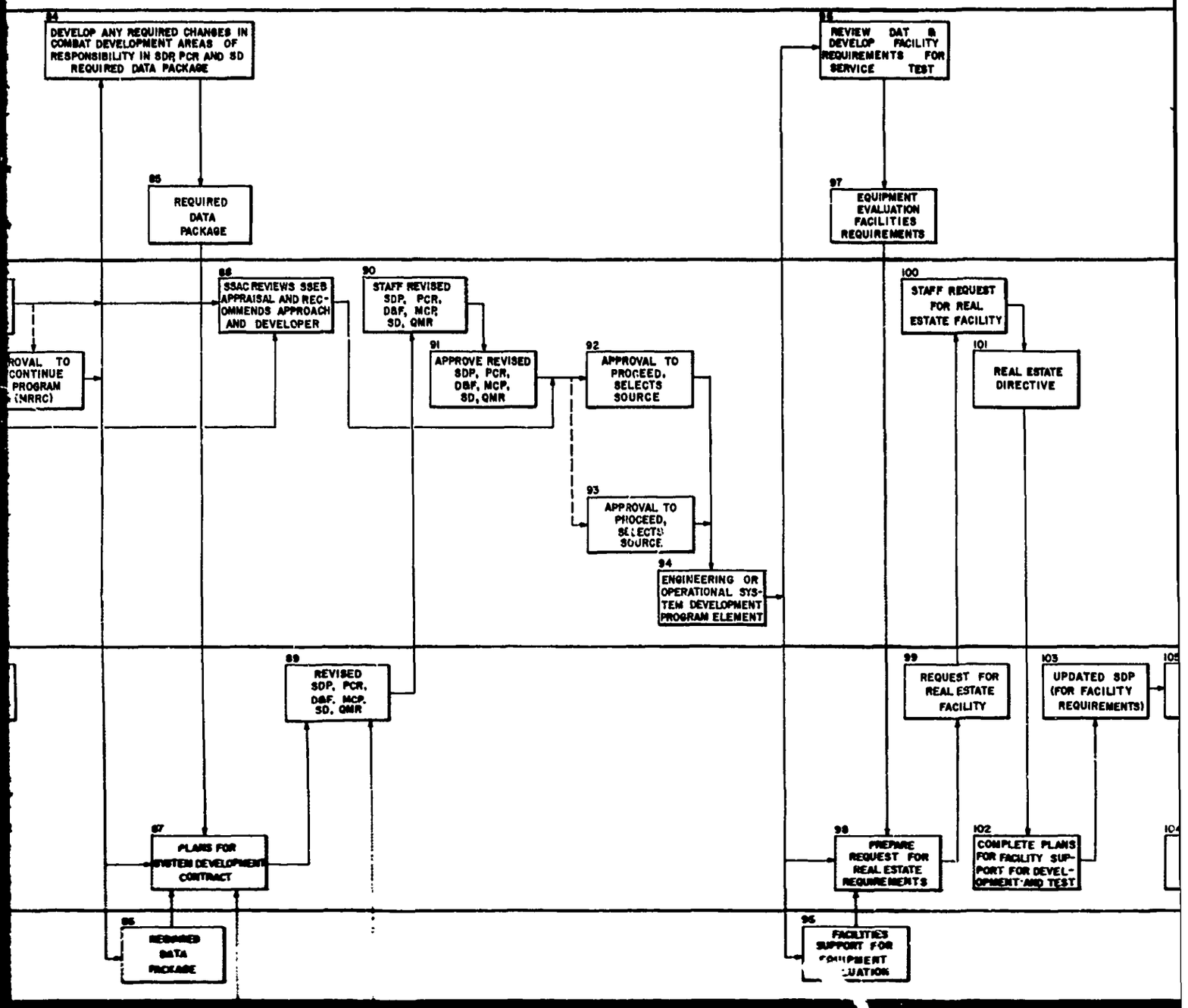
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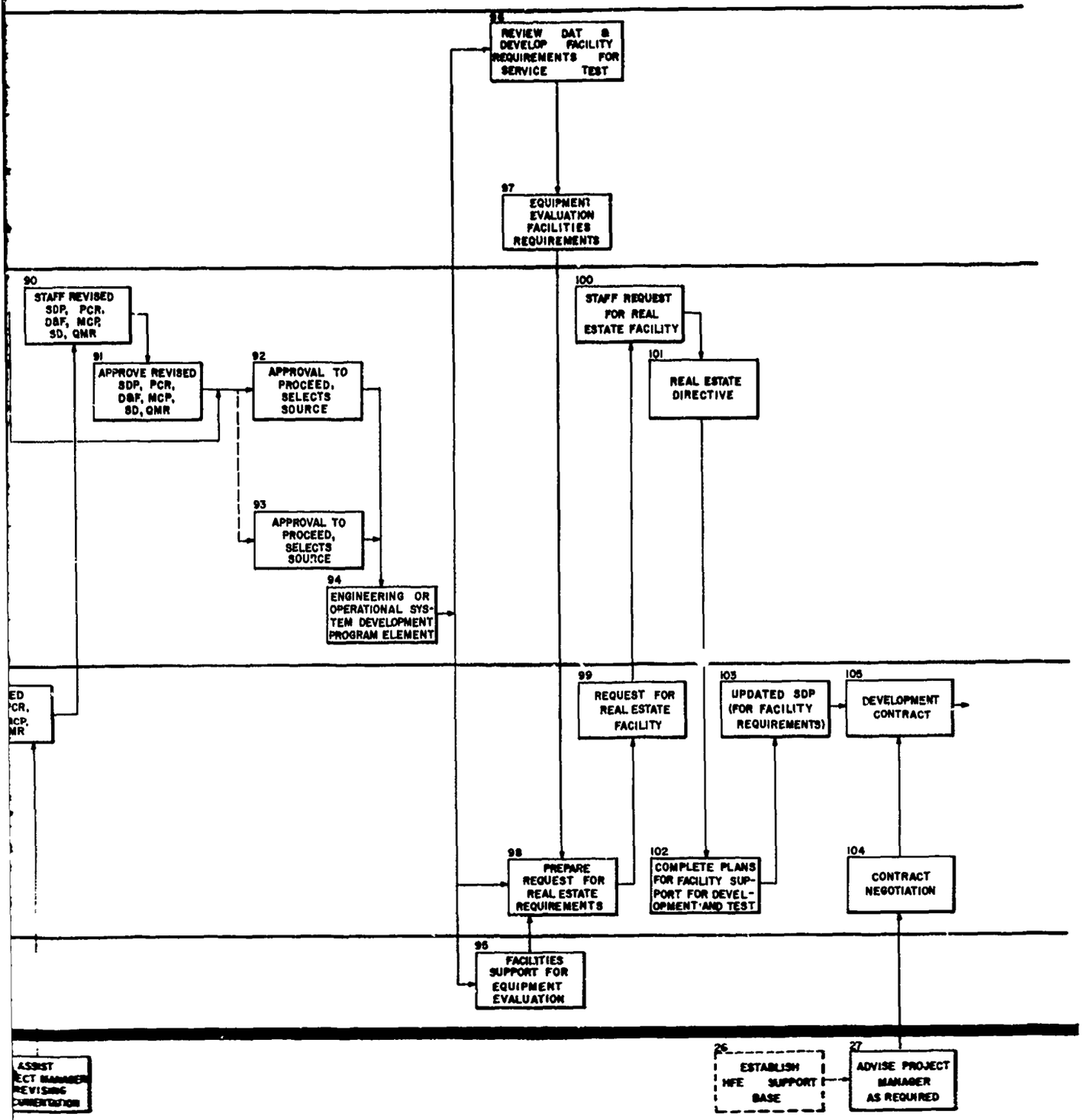
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